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Assessment of Long-Term Investing in Stock Markets

Zhodnocení dlouhodobého investování na akciových trzích

Student: Xiaoshan Feng

Supervisor of the bachelor thesis: Ing. Kateřina Kořená, Ph.D.

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3. Development of the Stock Markets
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List of Abbreviations
Declaration of Utilisation of Results from the Diploma Thesis
List of Annexes
Annexes

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Ing. Iveta Ratmanová, Ph.D.
Head of Department

prof. Dr. Ing. Zdeněk Zmeškal
Dean

The declaration

"I hereby declare that I have elaborated the entire thesis including annexes myself. I have supplemented the provided annexes No.1-6 myself."

Ostrava dated 25.04.2018

Xiaoshan Feng

Student's name and surname

Contents

1 Introduction

In recent years, the global stock market has surged, and the world economy has speeded-up its recovery. More and more investors are addicted in optimism about the stock market. However, such indication reminded us the days around financial crisis 10 years ago, at which such a stock market continues to rise, the market has already developed insensitively, and it is inevitable that the next stock market crash will occur. Therefore, we should understand the long-term development cycle and the regular pattern of the stock market. It may help investors to make better investment choices.

The objective of this thesis is to assess long-term investing in the global stock markets through important indicators such as moving average and volatility. In addition, we will use econometrics to analyze the relationships between stock indices and macroeconomic indicators such as interest rate and inflation.

In this thesis, we select countries, which are important economic powers in the world, such as the United States, China, Japan and Germany. By analyzing these countries, we may know the situation of the global stock markets and have an image of the future development of the stock markets.

There are five parts in this thesis, first part and last part is introduction and conclusion.

In Chapter 2, we will focus on the description of the basic characteristics of stock markets and the method of assessment. We will define the econometrics method, moving average and volatility analysis.

Chapter 3 is focused in the development during past 30 years of the main stock markets in the world. As well as the stock indices of selected stock markets, such as S&P 500, SSE Composite, DAX and Nikkei 225.

In Chapter 4, we use the theory in Chapter 2 to calculate the moving average and volatility of selected stock markets and analyze relationships between representative stock indices and their interest rate and inflation through the help of STATA.

By these three chapters, we can have a review of historical development of global stock markets and make the investor more clearly to make their choices in future stock investing.

2 Characteristics of Stock Markets

Chapter 2 focuses on the main characteristics of stock markets, in which we will describe basic information of main stock markets in the world, and the basic knowledge of stock exchange as well as the trend of global stock markets, meanwhile, we will introduce the methods of assessment, which we will apply in the thesis. This chapter is based on the knowledge of Madura (2011) and Mishkin (2013).

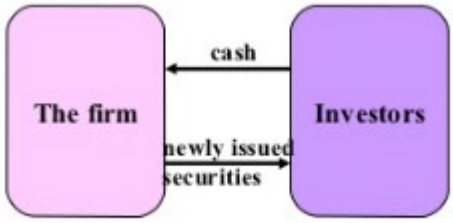
2.1 Description of Main Stock Markets

The predecessor of the stock markets originated from 1602 at which the Dutch bought and sold shares of East India Company on the Bridge over Amstel River, while the earliest stock markets was appeared at America. In general, stock market is the place at which speculators and investors to take part in. The stock market is one of the most important of finance for companies, and provides public trading for businesses, or to raise additional capital for expansion by selling shares of the company in an open market. It is also a predictor of the economic activity of a country or a region through the movement of the stock markets. The most important characteristics of stock markets is “volatility”.

2.1.1 Classification of Stock Markets

The stock markets can be divided into two main parts: primary and secondary market. *Primary market* is the first place to sell new shares through the initial public offering (IPO). The value of the company's listing and the number of its shares decide the stock price of the first public issue. In primary market, the transaction is conducted between the issuer and the buyer, at which create new stock and offer them to the public. In primary market, investment bank plays an important role as a financial institution that help first selling share of company. Investment bank acted as an underwriter, who help to underwrite stock, and ensure the stock can be sold at a proper price and then sell the stock to the public.

Diagram 2.1-The Primary Market



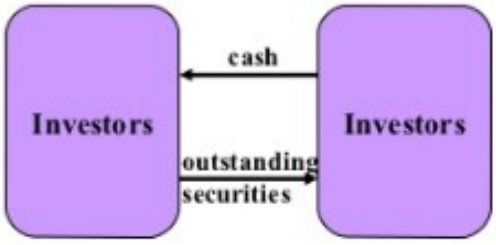
Source: https://www.slideshare.net/anicalena/financial-markets-business-diagram

The main function of primary market is to provide funds for fund demanders such as a

new company in the establishment, the capital increase or debt of the old company must be through the issuance of the market, and the capital must be raised through the occurrence and sale of stocks. Secondly, it can provide investment opportunities for fund providers to realize the conversion of savings to investment. Meanwhile, it can promote a continuous optimization of resource allocation. In the issuance process, the issuer does not normally deal directly with the investors. It requires an intermediary to handle it, such as a stockbroker. Therefore, the primary market is also known as the stockbroker market. The characteristics of the primary market of the stock are that there are no fixed places, which can take place in investment banks, trust and investment companies, stock companies, etc., or they can publicly sell new shares in the market. Second, there is no uniform transaction time, which depend on the issuers of the stock themselves when to issue and on the market movement. Primary market consists of three main factors linked to each other. The three are stock issuers, stock underwriters and stock investors. The issuer's stock issuance size and investor's actual investment capacity determine the stock's capacity and degree of development in the issuance market. At the same time, in order to ensure the smooth progress of the affairs, the issuers and investors can smoothly achieve their goals. Markets for the acquisition and underwriting of stocks are issued by the intermediary issuing stocks on behalf of the issuer and charging the issuer with formalities. In this way, the issuance market is centered on the underwriters, single-handedly contact the issuer, contact investors in one hand, and actively carry out stock issuance activities.

All subsequent transactions are carried out in the *secondary market*, including institutional investors and individual investors. The secondary market refers to the market formed by the transactions of issued securities between different investors. At the same time, the secondary market can provide liquidity of the stock, the reason to maintain the liquidity of stock is that it allows stockholders to sell their valuable stock at any time and realize liquidity, while if the stockholder can't realize their stock at any time, it will cause no one to buy the stock.

Diagram 2.2-The Secondary Market



Source: https://www.slideshare.net/anicalena/financial-markets-business-diagram

The functions of secondary market, firstly, is to promote the *transformation* of short-

term idle funds into long-term effectively funds. Second, to *regulate* capital supply and demand, therefore, to *guide* capital flows, build a communicate channels for savings and investment. Moreover, movement in stock prices in the secondary market can reflect the economic situation of the entire society. It is helpful to adjust labor productivity and the rise of newly developed industries. Finally yet importantly, to maintain a reasonable price of stocks, promote a market with *freedom of trading*, well informed, well managed. In addition, ensure that the benefits of both buyers and sellers are closely protected. Once the issued shares have been listed, they entered the secondary market. After that, investors can choose to buy or sell stocks according to their own judgments and needs. The buyer and the seller determine the transaction price. The price of the stock bought by investors on the same day is different. Try to use less passive voice generally

There are two kinds of trading type in secondary market, which are

- Stock Exchanges;
- Over-the-counter (OTC).

Stock exchanges, a more transparent market at which can provide to trade stock. The shares entering the transaction must be registered on the stock exchange and approved for listing, meanwhile, stocks listed in the stock exchange must trade through the trading system of each stock exchange. According to regulations, only members, qualified brokers, and stock dealers of the exchange are eligible to enter the trading floor for trading. Big stocks usually traded through the stock exchange. Now, most of the stock markets transactions are executed electronically, and even the stock itself is usually held in the form of electronic form. This kind of communication make the stock transaction becoming more convenient. The stock transactions completed on the stock exchange formed the prices of various stock, because the trading of stock conduct centrally and openly. The use of bilateral bidding to achieve a transaction is approximately fair and reasonable at the theoretical level. Such a price is announced to the public in a timely manner and is used as an important basis for various related economic activities. In this thesis, we will introduce and analyze the most important stock exchanges in the world, such as New York Stock Exchange in US, Shanghai Stock Exchange in Mainland China, Hong Kong Stock Exchange in Special Administrative Region of China, Frankfurt Stock Exchange in Germany, and Tokyo Stock Exchange in Japan.

Table 2.1.1-World's top 10 stock exchange

Rank	Stock Exchange	Total Market Capitalization
1	New York Stock Exchange	$19.6 Trillion
2	NASDAQ Stock Exchange	$8.13 Trillion
3	Tokyo Stock Exchange	$5.12 Trillion
4	Shanghai Stock Exchange	$4.27 Trillion
5	London Stock Exchange	$3.61 Trillion
6	Euronext Amsterdam Stock Exchange	$3.49 Trillion
7	Hong Kong Stock Exchange	$3.37 Trillion
8	Shenzhen Stock Exchange	$3.24 Trillion
9	Toronto Stock Exchange	$2.07 Trillion
10	German Stock Exchange	$1.77 Trillion

Source: https://www.stockmarketclock.com/exchanges

Over-the-counter, a decentralized market where brokers or dealers negotiate with each other directly by electronic system such as mobile phone or internet system. Stocks traded there can be listed or unlisted, while the main trading target is stocks that are not listed on the exchange. The stock markets price in OTC is negotiated between the parties of the transaction. OTC is the main place for stock issuance. The time of issue new stock is concentrated, and the quantity is large. It requires numerous sales outlets and flexible trading hours. OTC is a broad intangible market that can meet the requirements of stock issuance. Investors can deal directly with the stock companies in person in OTC market, not only the transaction time can be flexible and decentralized, but transaction procedures also can be simple and convenient, and prices can be negotiated. This transaction method can meet the needs of some investors.

Table 2.1.2-World OTC Market Size

Stock Market	OTC market Capitalization
USA	$32.3 Billion
CHINA	$22.4 Billion
JAPAN	$7.5 Billion
GERMANY	$5.0 Billion
RUSSIA	$4.8 Billion

Source: https://nicholashallcompany.wordpress.com

The United States has the biggest size of Global OTC market, China ranked 2nd in the world, Germany ranked 4th.

2.1.2 Functions of Stock Markets

Function of stock markets are as following:

- Raising funds;
- Conversion mechanism;

- Optimize the allocation of resources;
- Diversify risk.

Firstly, *raising funds* is the primary function of the stock markets. Through stock issuance in the stock markets, enterprises gather idle funds scattered in the society and form huge amounts of capital that can be used for a long time to support large-scale production and operation. The scale and speed of fundraising in stock markets is easier compare to enterprises depending on their own accumulation and bank loans.

Second is *conversion mechanism*. In stock markets, public trading can promote the company to change management mechanism and establish a modern system. From many shareholders, the company must fulfill its obligation of information disclosure, which makes the company always be supervised and influenced by all aspects. Such as shareholders, capital market, and social. From the supervision of shareholders, shareholders as investors must be concerned about the company's financial situation and development of the company, thus through the authorization relationship to implement their powers. From the capital market, company's performance will affect the stock price, the stock price affects businesses and investors, poor management, stock prices may result in the acquisition by a third party. From supervision of society, especially from the supervision and control of accounting firms, law firms, stock exchanges and public opinions. All of these oversight and constraints prompted listed companies to improve and complete the internal operation mechanism.

The third is to *optimize the allocation of resources*. The optimal allocation of resources in stock markets achieved through fundraising in the primary market and flow of funds in the secondary market. This will allow funds to gradually flow to companies which have good returns and good prospects of development, thus promote their share prices rise gradually that provided a good operating environment for the company to capitalize on the stock markets. However, the companies whose performances are poor, stock prices eventually declined, resulting in disappear or mergers and acquisitions. Which imply the Matthew Effect, the strong get stronger, the weak get weaker.

The last is *diversify the risk*. Stock market provides investors with investment and financing channels, it also provides a way to diversify risks. From the point of view of fund demand, funds are raised through the issuance of stocks, and at the same time, the operational risks are partially transferred and distributed to investors, thus realizing the diversification of risks. From an investor's point of view, the risk can be shifted and diversified by buying and selling stocks and establishing a portfolio based on how much the individual takes the risk.

Investors who has idle funds can buy shares for investment, transfer the consumer funds into production funds, while who has tight funds can sell the stock into cash to solve the demand for immediate payment. The high volatility of the stock markets makes people who have idle funds willing to invest into the stock markets, so that idle funds into productive capital. This process not only maximize the use of scattered idle funds but also promoted the preservation and appreciation of personal wealth.

2.1.3 Main Participants in Stock Markets

The participants in the stock markets can be divided into two main categories: one is the real buyer and seller, that is, the main body of the transaction; the other is the financial market media, also known as the financial intermediary. Participants can also be divided into:

- Households;
- Businesses;
- Governments.

They are all major capital providers or fund demanders in the stock markets, therefore, they are the main participants in the stock markets. The *household sector*, sometimes called the individual sector, is an important fund supplier in the stock markets, and a major investor in the stock markets. *Companies* who involved in the production of goods and need financing so that to be closely linked with the stock markets. The diversification of the company's capital sources and the diversification of investment entities mean that the company has become the main body of stock issuance on the stock markets and has become the main factor determining the size of the primary market. In addition to be the largest financial demander and the main body of transactions in the financial market, the *government* is still an important regulator and regulator, and therefore it has double identities in the financial market. The issuer of stock refers to the issuer of bonds, stocks and other stock issued for raising funds. In this thesis, we will only focus on the stock issuers (see Madura 2011).

Including companies, governments and its institutions, stock investors are legal entities and natural persons of various types that make investments by buying stock. Correspondingly, stock investors can be divided into:

- Institutional investors;
- Individual investors.

Institutional investors mainly include government institutions, financial institutions, corporate and institutional corporations, and various types of funds institutions. The purpose of

government institutions involved in stock markets is mainly to adjust the balance of funds and macro control. The central bank uses open market operations as a policy measure to conduct macro control by buying and selling government bonds or financial bonds that affect the level of money supply or interest rates. The financial institutions involved in stock investment include stock operation institutions, banking financial institutions, insurance operation institutions and other financial institutions. Since some financial institutions hold large number of stocks, their collective sales or purchase of stocks can significantly affect the stock markets price. In addition to investment funds, financial institutions participate in the stock markets sometimes to issue their own stock as a way to raise funds. A company can control its shareholding in other companies through stock investment. It can also use its own funds that are temporarily idle to obtain profits through self-business or entrusting professional institutions to invest in stock. Commercial banks also will participate in stock markets for issuing stock to boost their capital base, and manage trust funds that usually contain stocks, as well as saving banks, which will invest in stocks for their investment portfolios.

Individual investors are social natural persons who are engaged in stock investment. They are the most extensive investors in the stock markets. Individuals investing in stock should have some basic conditions. These conditions include the provisions of relevant state laws and regulations on individual investor investment qualifications and individual investors better have a certain degree of capital. In order to protect the interests of individual investors, for certain high-risk involved, the regulatory regulations also require that relevant individuals have certain product knowledge and sign written informed consent.

Stock market intermediary refer to various agencies that provide services for the issuance and trading of stocks. The institutions that mediate the stock markets are stock companies and stock service agencies. The latter include stock investment consulting agencies, stock registration and settlement agencies, financial advisory agencies, credit rating agencies, asset assessment agencies, accounting firms, and law firms. In case of the regulation of stock markets, there are self-regulatory organization of the stock markets, which mainly includes stock exchanges and industry associations. Stock regulatory agencies' main responsibilities are: formulating regulations and rules concerning the supervision and management of the stock markets in accordance with the law, supervising the implementation of relevant laws and regulations, protecting the legal rights and benefits of investors, and implementing laws and regulations on stock issuance, stock trading, and intermediary operations within the country. Therefore, to maintain a fair and orderly stock markets.

2.1.4 Classification and Role of Stock Exchanges

The stock exchange is a market for buying and selling stock, corporate bonds, public debt, and other stock. Collect buyers and sellers of stock, through the stockbroker to complete the transaction. The existence of stock exchanges has created a permanent market for stock trading and has become an institution through which money capital is used to realize long-term investment, as it is often referred to as a long-term financial market. In some countries, stock exchanges are the core of the economy.

The stock exchange has the following functions:

- Provide trading place;
- Provide information of stock trading;
- Provide liquidity to investors;
- Guide rational flow of investment.

First, due to the existence of this market, the buyers and sellers of the stock have centralized trading venues, and they can transfer the stock they hold at any time to ensure the continued circulation of stock. The second is the formation and announcement price. The stock transactions completed on the exchange formed the prices of various stocks, as the trading of stock was conducted centrally and openly. The use of bilateral bidding to achieve a transaction is approximately fair and reasonable at the theoretical level. Such a price is announced to the public in a timely manner and is used as an important basis for various related economic activities. Third, all kinds of social funds are concentrated to participate in investment. With the increasing number of exchange-listed stocks and the increasing number of transactions, it is possible to attract a very wide range of funds to the stock investment and provide necessary funds for the development of the company. The fourth is to guide the rational flow of investment. The exchanges provide convenience for the free flow of funds and reflect the profitability and development of the stock issuing company through the disclosure of daily market information and listed company information. Make social funds flow in the most needed and most favorable direction.

2.1.5 Definition and Role of Stock Indices

The stock index is the stock price index, which is a kind of instructional indicator that is compiled by stock exchanges or financial service agencies to indicate changes in the stock markets. As stock prices fluctuate, investors have to face market price risks. For a specific stock price changes, investors easily understand, but for a variety of stock price changes, it is difficult to understand. In order to adapt to this situation and needs, some financial service organizations

use their own business knowledge and familiarity with the market as the advantages to compile the stock price index and publish it publicly as an indicator of market price changes.

There are main two types to compile the stock price index. First is the price-weighted index, which be applied to the longest history stock index-Dow Jones Industrial Average(DJIA). The equation of compile shows in the follow.

$$DJIA_t = \frac{\sum_{i=1}^{n} P_i}{D_t} \tag{2.1}$$

In which numerator is the sum of stock price, and n represents the number of sample shares in the index, D_t is the divisor of the moment t. When the index launched, it included just 12 companies that were almost purely industrial in nature, so that the divisor is 12.

The other way is market-value-weighted-index, which is most frequently used by most country and region. Such as NYSE Composite Index, Hang Seng Index, S&P 500. As an example of S&P 500, the equation shows following.

$$S\&P500 = \frac{\sum_{i=1}^{n} Q_i P_i}{OV} \times BIV \tag{2.2}$$

In which the numerator is the number of shares outstanding in the nth sample stock times price of the sample stock, OV is the weighted average price index base period, BIV is points of base period, which be set as 10. Investors can judge the trend of stock price changes based on the movement of the index. And in order to be able to reflect the trend of the stock markets to investors in real time, all the stock markets almost immediately announced the stock price index at the same time as the stock price changes.

The stock index is not only an important indicator reflecting the changes in the stock markets, but also a reference indicator for observing the economic situation and the cycle status. The stock price index mainly has the following basic functions: First, it comprehensively reflects the direction and degree of change in the stock price in a certain stock markets during a certain period. The second is to provide information for investors and analysts to study and judge the dynamics of the stock markets, which facilitate the analysis of the general trend of the stock markets. Third, as a benchmark for investment performance evaluation, it provides a benchmark yield for stock markets investment. The fourth is provide more financial innovations such as index derivatives. Based on this, investors can test the effectiveness of their investment and use it to predict the movement of the stock markets. At the same time, the press, the company's CFO, and even political leaders also use this as a reference to observe and predict social and political development.

2.2 Method of Assessment

In this part, we will introduce moving average method and volatility analysis to help us analyze the profitability and stability of long-term investing in selected stock markets. Simultaneously, we will describe the methodology of econometrics analysis for assessing the relationship between stock index in long-term and macroeconomic indicators.

2.2.1 Moving Average Method

The moving average method is a simple smooth prediction technique and is a tool for analyzing time series data in technical analysis. Its basic idea is to calculate sequentially the time-series averages that contain a certain number of items based on time-series data and item-by-item changes to reflect long-term trends. Therefore, when the value of the time series is subject to periodic fluctuations and stochastic fluctuations, fluctuations are large, and it is not easy to show the development trend of the event, using the moving average method can eliminate the influence of these factors and show the development direction and trend of the event.

When we use moving average to analyze stock price, it shows the average price of the stock price during a certain period. When the moving average is calculated, the stock price is flattened over this period. As the stock price changes, the moving average will also increase or decrease.

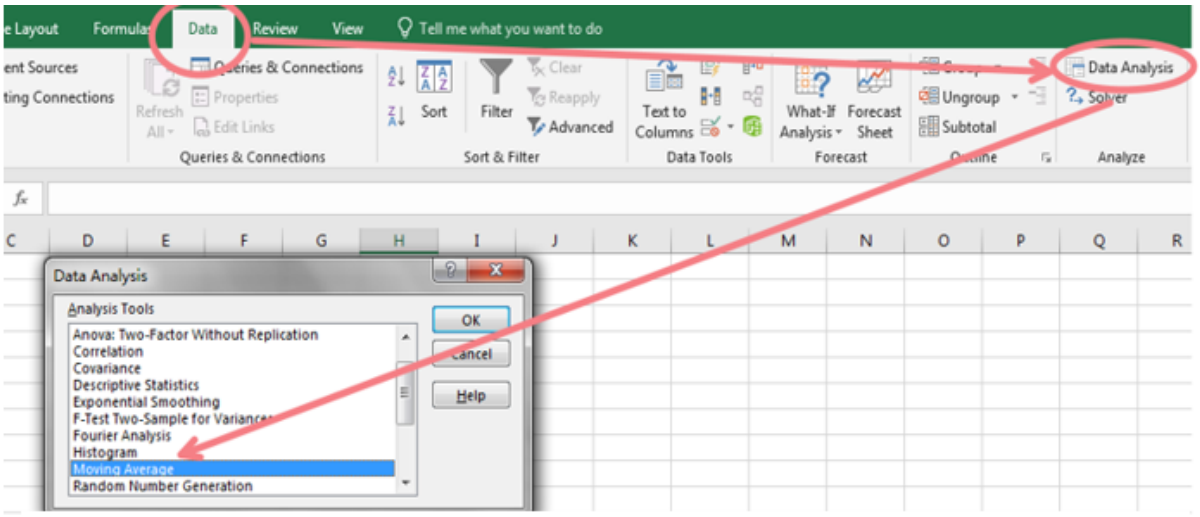
There are four different types of moving averages: simple moving average (SMA) exponential moving average (EMA), smooth moving average (SMMA), and linear weighted moving average (LWMA). Moving averages can be calculated for any continuous data set, including opening and closing prices, high and low prices, trading volume or any other indicator. Sometimes, different types of moving averages will generate considerable disagreement, which is the case of assigning different weight coefficients to the later period's data. However, as for simple moving average, the price weights are equal for all time periods involved in the problem. The exponential moving average and the linear weighted moving average assign more weight to the price in later period. In this thesis, we will mainly use simple moving average.

The more common way to explain the average price movement is to compare it with the price action. When the stock price rises above its moving average, the buy signal appears, when the price falls below the moving average, what we get is a sell signal.

Trading systems based on moving averages are not designed to enter at the lowest point and leave the floor correctly at the peak. It can act on the following trends: buy as soon as the

price reaches the bottom and sell it as soon as the price hits the top. We can easily use excel to help us to conduct the progress of calculating simple moving average.

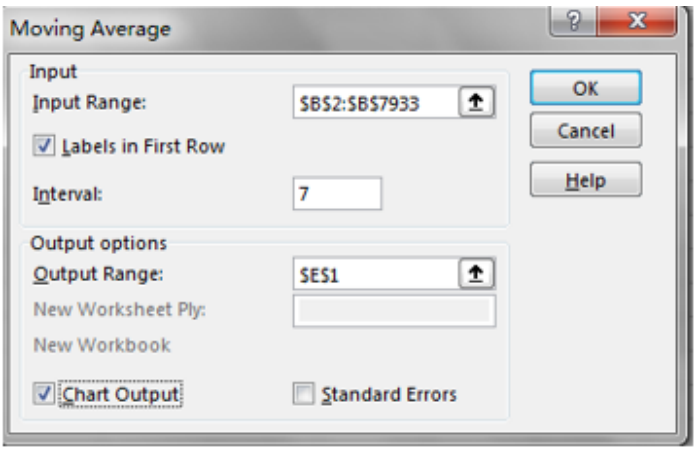
Table 2.1.3- Progress in Excel



Sources: Excel

As we can see from the table 2.1.3, which shows the step by using excel data analysis to help calculating, then we will get a table to insert the date set.

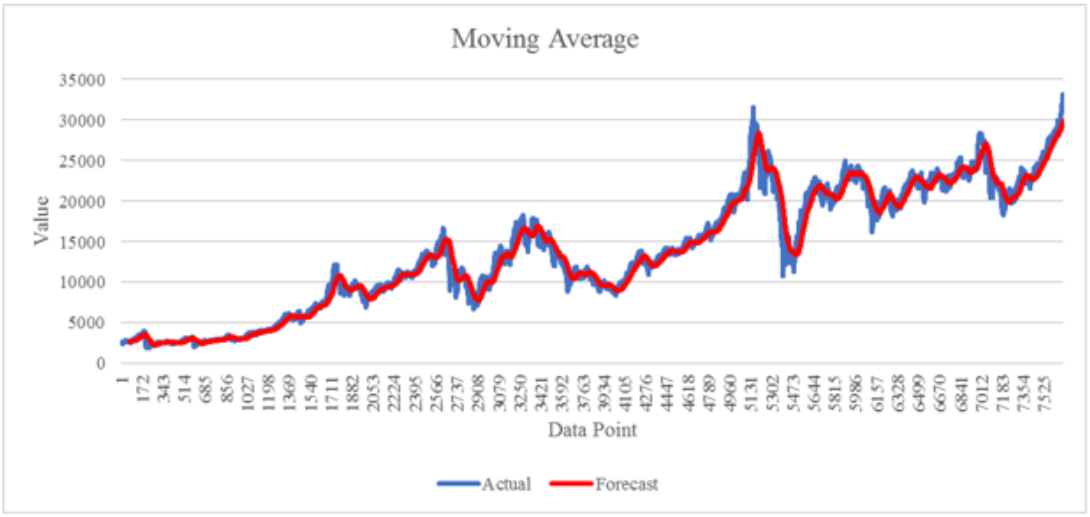
Table 2.1.4- Moving Average Data Insert Table



Sources: Excel

The table above shows the data insert progress, first we need to choose the data set in to the "*Input Range*", in this thesis, we will insert stock closing price of index. Then we will set "*Interval*", which depends on our calculation, increasing the interval number will make the smoothing fluctuation effect better, but it will also make the prediction value less sensitive to the actual change of the data, so the moving average interval should not be too large. Then we choose to have result with chart, we can click "OK" to see the result.

Figure 2.1- Example of moving average

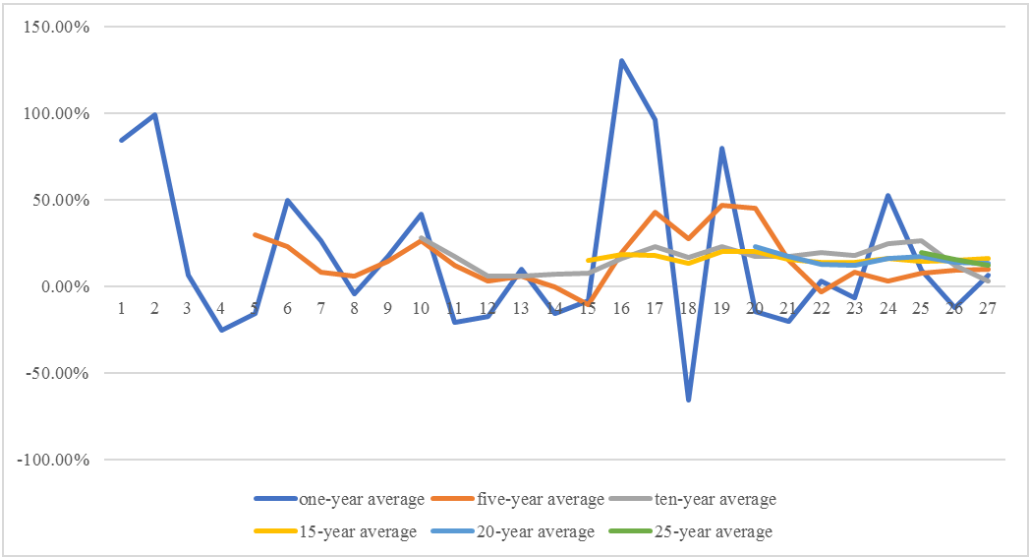


Sources: own calculation

This example is a line chart drawn with an interval of 70, which has 7683 data. From the chart, we can see the moving average smooth the original data and we can see that the "Forecast" data series is much smoother than in "Actual". In our thesis, we will use this method to help us to plot trend of the long-term development of the stock indices.

With help of moving average method, we can also compare the short-term investing and long-term investing with the moving average yield. In this thesis, we will use one-year average yield and accumulated every five-year until 25-year average. The result can be interesting, when investor involves in short-term investing, the annualized yield can be very unstable and unprofitability than long-term investing.

Figure 2.2-Example of moving average yield



Source: author

Figure 2.2 shows the example of moving average yield of SSE composite Index, we can see shorter the investing period, unstable of the yield, while longer of the investing period, more

stable of the yield. We will use this method in Chapter 4 for more detail analysis.

2.2.2 Volatility Analysis

In the stock markets, two things people mostly care about risks and returns. Although, to a certain level, the high return also with high risk. However, relatively safe investment strategies are those with low risks and high returns. While in the stock markets, volatility in stock prices is directly related to risk. It is generally believed that markets with large stock price volatility are higher risk, while markets with low stock price volatility are lower risk. Therefore, in many trading strategies, it is recommended to only trade in low-volatility and low-risk markets. In general, we can know volatility is important to measure the stock markets, it can be used to determine the type of market trend. The types of market trends include: trends, no trends, and highly volatile markets.

To measure volatility of stock, the most frequently used is standard deviation, which is a typical and easy way to figure out with help of Excel. First, we need to calculate the daily log return, the reason why we use log return is to make sure the return will normal distribution, which is an important assumption of modern financial mathematic.

As shows in the following:

$$Return = ln(\frac{P_t}{P_{t-1}}) \tag{2.3}$$

Then we need to calculate the daily volatility of the historical data we collect by using the standard deviation function of excel. To calculate the annualized volatility, we will square root the business day in a year which is counted as 252, than times the daily volatility.

Table 2.1.4- Excel calculation of volatility

B	C	D	E	F	G	H
Adj Close						
2568.3		=LN(B3/B2)				
2540.1	-0.01104					
2552.4	0.004831		Daily volatility	=STDEV.S(C3:C7683)		
2583.9	0.012266		0.016708			
2607.1	0.008939					
2603.3	-0.00146		Annualized volatility			
2561.7	-0.01611		0.265226			
2614.9	0.020555			=SQRT(252)*E5		
2590.8	-0.00926					
2578.2	-0.00488					
2559.1	-0.00744					
2542.6	-0.00647					

Sources: own calculation

The table above is the example of the calculating volatility by excel.

2.2.3 Econometrics Analysis

Econometrics analysis is based on certain economic theory and statistical data. It uses mathematics, statistical methods and computer technology to establish an econometric model as the main means to quantify and analyze an economics relationship that has the characteristics of randomness. Theoretical testing is the most important and reliable aspect of econometric use. This is also a major part of econometrics itself. Steps of an econometric analysis are in the following, firstly, we need to collect data we choose to analyze, then we will make formulation of an economic model based on the economic model, after that, we will do estimation of the econometric model, by verifying the model, we will interpret the results based on the model. In this thesis, we will under the help with Stata, which is a general-purpose statistical software package.

The most important thing we applied econometric analysis should start with setting dependent variables and explanatory variables, which represent some population, and we will figure out "how x influences y", or "explain y in terms of x". In our thesis, we will discuss the relationship between stock indices and macroeconomic factors, which include: y is adjusted price of stock index in specific country, or a region, and x_1 is interest rate of a specific country, x_2 is inflation of this country. We can resolve these ambiguities by writing down an equation relating y to x.

$$y = \beta_1 + \beta_2 x_1 + \beta_3 x_2 + u \tag{2.4}$$

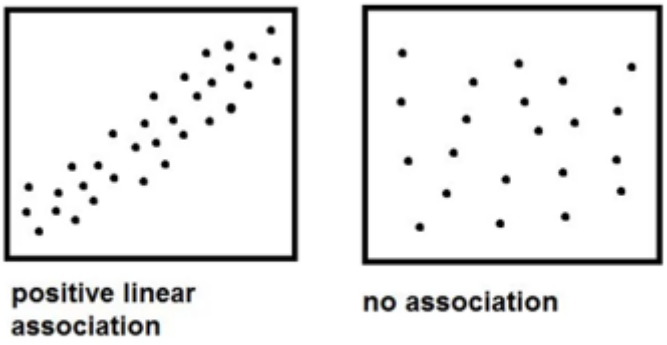
Equation (2.4) can be defined as simple linear regression model. The variable u, can be called as the error term in the relationship, represents factors other than explanatory variables x that affect dependent variables y. The reason why we need to add error term into the equation, because we need to consider the unavailable data may have omission of many minor influences, and there may exists measurement error and possibly incorrect functional form or stochastic character of unpredictable human behavior.

We will use the Ordinary Least Squares, OLS is used to fit the regression line by minimizing the sum of vertical distance between the regression line and the observed points. When the OLS was used for parameter estimation, R-squared was the ratio of the sum of squared regressions to the sum of the squared sums of the total deviations, indicating the proportion of sum of squared sums that can be explained by regression sums. The bigger the proportion, the better. The more accurate the model, the more significant the regression effect. The R-squared is between 0 and 1, the closer to 1, the better the regression fitting effect. It is generally believed that the goodness of the model is higher than 0.8.

After we set econometrics model, the main task for us is to find the value of parameters $\beta_1$and β_2 and β_3, in which β_1 stands for intercept parameter, β_2 stands for slope parameter for x_2, while β_2 stands for slope parameter for x_3.There are five hypotheses of regression, Linear relationship; No auto-correlation; No or little multicollinearity; Homoscedasticity; error term normality.

First, linear relationship assumption, that is, the dependent variable is the linear function of a set of explanatory variables plus the error term. If you fit a linear model to a non-linear, non-additive data set, the regression algorithm would fail to capture the trend mathematically, thus resulting in an inefficient model. Also, this will result in erroneous predictions on an unseen data set. First, linear regression needs the relationship between the independent and dependent variables to be linear. It is also important to check for outliers since linear regression is sensitive to outlier effects. The line linearity assumption can best be tested with scatter plots, the following two pictures shows the examples, where positive linearity and no association is present.

Plot 2.1-Linerity testing

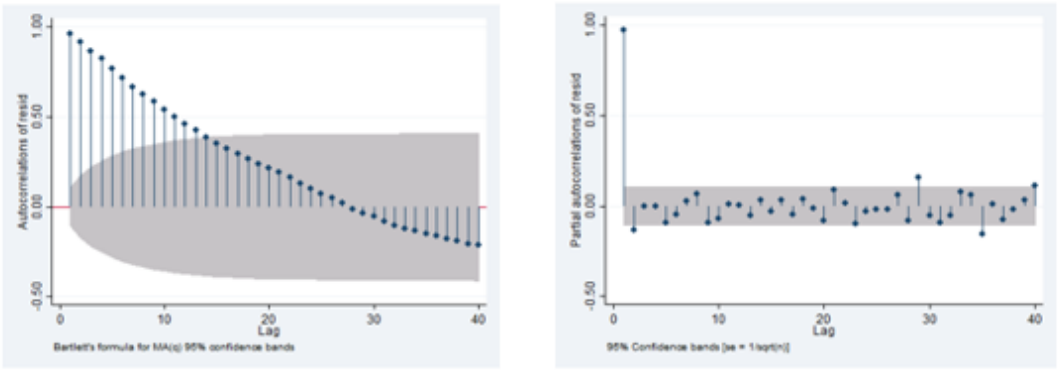


Sources: www.mathbootcamps.com/reading-scatterplots/

Secondly, *Autocorrelation* is correlation between members of series of observations ordered in time. In the regression the classical linear regression model assumes that such autocorrelation does not exist in the error term. The presence of correlation in error terms drastically reduces model's accuracy. This usually occurs in time series models where the next instant is dependent on previous instant. If the error terms are correlated, the estimated standard errors tend to underestimate the true standard error. If this happens, it causes confidence intervals and prediction intervals to be narrower. Narrower confidence interval means that a 95% confidence interval would have lesser probability than 0.95 that it would contain the actual value of coefficients. There are two methods for testing autocorrelation, first is graphical methods, by using Residual autocorrelation function (ACF) and partial autocorrelation function

(PACF) can display and plot the sample and partial autocorrelation function of time series.

Plot 2.2-ACF and PACF

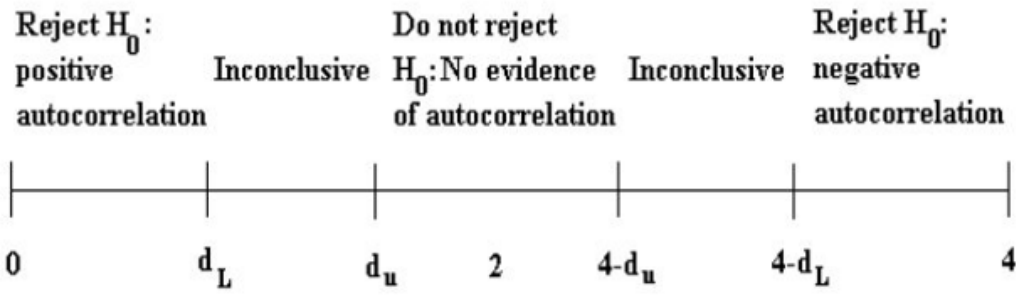


Sources: Own plot

The other method is Durbin-Watson (DW) statistic. To perform the Durbin–Watson test, we define critical values of d, the critical values, at any significance level, depend on the number of observations in the sample and the number of explanatory variables. As following shows the equation of d. The null hypothesis is H_0: no autocorrelation. If d lies between these values, we do not reject the null hypothesis.

$$d = \frac{\sum_{t=2}^{n}(\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=2}^{n} \hat{u}_t^{\,2}} \tag{2.5}$$

Picture 2.1-Rules of autocorrelation



Sources: Introductory Econometrics for Finance

If there is no autocorrelation, d should be distributed randomly around 2; If there is severe positive autocorrelation, d will be near 0; If there is severe negative autocorrelation, d will be near 4. However, DW statistic determined upper and lower bounds, d_u and d_L, for the critical values, and these are presented in standard tables.

If we have detected our model exists autocorrelation, we need to eliminate autocorrelation for more precisely prediction. There are various methods for elimination of serial autocorrelation. The most frequently use is to include lagged dependent variable as explanatory variable. Cochrane–Orcutt(CO) method, in this method, first is to estimation of ρ parameter which is coefficient, then make variables transformation, last is to estimation of the

transformed model.

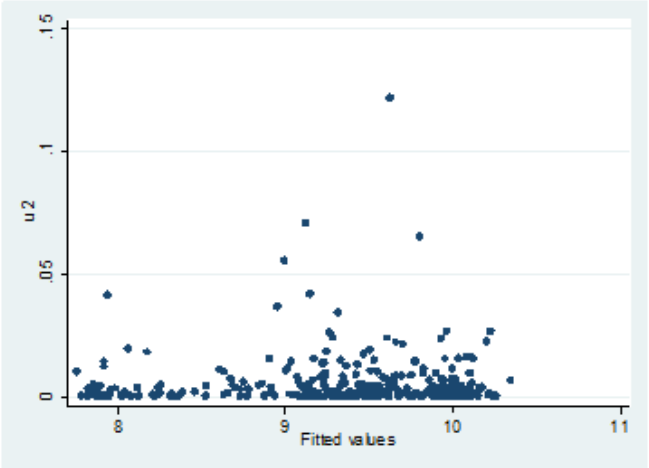
The third assumption of classical regression model is that among the regressors included in the regression model is *no multicollinearity*. It means that the does not existence of a perfect linear relationship among some or all-explanatory variables of regression model. When the explanatory variables are found to be highly correlated, it is hard to figure out the true relationship of a predictors with response variable, meanwhile, with existence of correlated predictors, the standard errors can be increasing, which will make the confidence interval becomes wider then leading less precise estimates of slope parameters. To test if our model exists multicollinearity, first, we can test pairwise correlation among regressors, if this number lower than 0.8, we can assume there is no multicollinearity between two explanatory variables. In addition, we can judge through looking at the scatter plot of explanatory variables. Then, for variables that may have multicollinearity, we look at the Variance Inflation Factor (VIF). If VIF less than 3, means there is no multicollinearity, if VIF larger than 10, which means there exists multicollinearity in model. When we found our model has multicollinearity, we can through dropping a variable from the model and specification bias.

Fourthly, linear regression analysis requires that there is *homoscedasticity*, which is that the variance of error term u is some constant number.

$$var(u_t) = constant\ for\ all\ t = 1,2,3, \dots n \tag{2.6}$$

The scatter plot is good way to check whether the data are homoscedastic, which means the residuals are equal across the regression line. The following scatter plots show examples of data that are not homoscedastic:

Plot 2.3 Heteroscedasticity plot



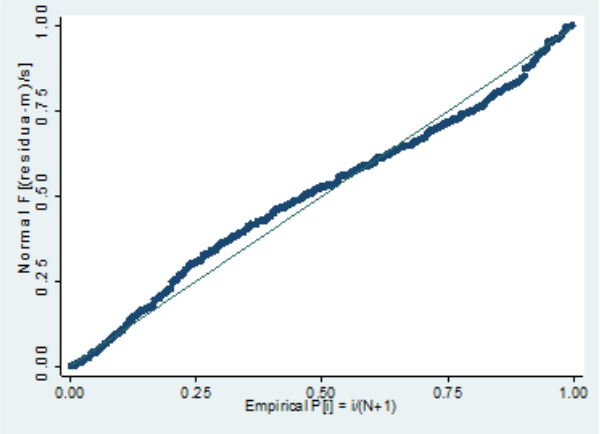
Sources: own plot

Meanwhile, we can use White general test to detect if heteroscedasticity exists. We can regress the squared residuals on explanatory variables in the model, their squares, and their

cross-products, omitting any duplicative variables. The null hypothesis is H_0: homoscedasticity. If we detect our model has heteroscedasticity, we need to eliminate heteroscedasticity by setting weight.

Last assumption of regression models is the error term has a *normal distribution*. If the error terms are non- normally distributed, confidence intervals may become too wide or narrow. Once confidence interval becomes unstable, it may lead to difficulty in estimating coefficients based on minimization of least squares. Existence of non – normal distribution suggests that there are a few unusual data points which must be studied closely to make a better model. This assumption can be checked with quantile-quantile plot (Q-Q-Plot), which shows in the following.

Plot 2.4- Q-Q-Plot



Sources: own plot

As we can see from the plot, if the error term satisfies the normal distribution, the scatter in the Q-Q-Plot will be approximately on a straight line. If the normal distribution is not satisfied, the scatter points will deviate from the straight line. Meanwhile, Normality can be checked with a goodness of fit test, for example, Jarque-Bera test.

3 Development of the Stock Markets

This chapter will describe and analyze the development of main stock markets in America, Asia, and Europe. According to the market capitalization of the world, we selected the most representative stock markets in the world, US stock market, Chinese stock market, Japanese stock market, and German stock market, respectively.

3.1 General Development of Global Stock Markets

With the world economy entering the strongest cycle since 2011, global stock markets are in a powerful bull market and the indices of main stock markets create record of new high. At the same time, investors are gradually returning to the stock markets. The global market is growing rapid and the total size of financial assets is also expanding. VisualCapitalist announced that[1] there are only 60 stocks that have sufficient stock to trade in more than 200 countries and regions of the world. These 60 major stock markets accounted for 93% of the world's stock trading, and their total market value reached 69 trillion US dollars. There are 16 large-scale stock markets each with a total market capitalization over 1 trillion US dollars, of the 16 large-scale stock markets, 8 are in Asia Pacific, 3 in the United States and Canada and 5 in Europe. In this thesis, we mainly describe the most important and representative stock markets as follow:

- USA Stock Market;
- Chinese Stock Market;
- Japanese Stock Market;
- German Stock Market.

Next, we will describe the development of each stock market in detail.

3.2 The United States Stock Market

The United States stock market is the most developed stock market in the world. Which has the largest market for stock issue and circulation, the quantity of the stock issuance and trading varieties are largest, as well as the capacity of the market and development level.

3.2.1 History of The United States Stock Market

The US stock market came from the late 18th century. The earliest stock market in the United States is from *Wall Street*. Wall Street as a world-famous international financial center

[1] Source: visualcapitalist [Online]. Available on: http://www.visualcapitalist.com/20-largest-stock-exchanges-world/

represent US stock market, there are many stock companies and investment banks and other financial institutions. The New York State Chamber of Commerce established on April 5, 1768 on Wall Street, which created a place for the formation of the stock market. At that time, all the businessmen gathered on Wall Street to buy or sell stocks, wheat, tobacco and other commodities, and even slaves. From 1789 to 1790, in order to make up for the cost of the American War of Independence, American Congress authorized to issue shares value $80 million. Since there was no official market for centralized transactions at that time, these transactions were made at Tontine coffee house and auction houses.

The origin of the NYSE dates to 1792, when 24 stockbrokers signed “Buttonwood Agreement” in a buttonwood outside Wall Street, the agreement lays down the rules of "Alliance and Cooperation" for brokers and trades stocks and premiums commodities through the club membership system, which is also the former of the NYSE. On March 8, 1817, the organization changed its name to New York Stock & Exchange Board. With the development of the transport, gas, and power industries, many companies rely on issuing stocks and other securities to raise construction funds. Thus, the amount of business has been continuously expanding. The coffee house can no longer meet the needs. In 1863 the board changed its name to the New York Stock Exchange.

At the beginning of the US securities market, from the point of view of the varieties of transactions, the major varieties initially traded on the major stock exchanges at that time were commodities, treasury bonds and newly independent municipal bonds, as well as shares of some banks and insurance companies. During 1860-1870, railroad stocks were widely trading in the US market, it began to transform from the past bond market to the stock market. However, most of the time before 1886, the US stock market dominated by treasury bonds, municipal bonds and corporate bonds. The stock market began to develop rapidly in the latter decades of the 19th century and make Wall Street become the main role in the global financial market.

On October 1, 1934, NYSE registered to the Securities and Exchange Commission of the United States as a national stock exchange with a chairman and a board of directors of 33 members. On March 7, 2006, the NYSE merged with Archipelago Holdings to form the New York Stock Exchange Group. In the next year, the New York Stock Exchange Group and NYSE Euronext merged to form the first global stock exchange. In 2013, Inter Continental Exchange has been approved to merge NYSE. At the end of 2016, NYSE has reach $25.8 trillion as the largest stock exchange in the world, with 2,400 listing companies. As the representative of the US stock market, the New York Stock Exchange occupies the world’s largest stock market with

a market value of 18.5 trillion US dollars. The NASDAQ stock exchange is closely following the New York Stock Exchange and has a market value of $7.4 trillion.

There are 7 main markets [2]trading in NYSE, such NYSE American, NYSE Arca, NYSE National. The securities trading in NYSE are mainly 4 types, Equities, ETFS, Options and Bonds.

3.2.2 Indices of The United States Stock Market

There are three major stock indices in the US stock market: the Dow Jones Industrial Average, the NASDAQ Composite, and the S&P 500. In addition, there are various stock indexes in the US stock market, such as the Russell 2000 Small Cap Index, the New York Stock Exchange Index, and the NASDAQ 100 Index.

The Dow Jones Industrial Average, DJIA, is the oldest stock index in the world. Which created by the Wall Street Journal and Dow Jones company founder Charles Dow. Today, the average index includes the 30 largest and best-known listed companies in the United States. DJIA is one of the most influential and authoritative stock indexes in the world. One of the reasons is that DJIA selected the stocks of representative companies, which are all well-known companies with significant influence in the industry. Their stock prices are the focus of the world stock market, and investors in all countries attach great importance. In order to maintain this characteristic, DJIA constantly replaces those companies' shares that have lost its representativeness with dynamic and more representative companies' shares.

NASDAQ Composite, NASDAQ is the abbreviation of the name of National Association of Securities Dealers, which is an *automatic quotation* system that established in 1968. NASDAQ's listed companies cover all new technology industries, including software and computers, telecommunications, biotechnology, retail and wholesale trade, such as Tesla, Inc. and Chimerix, Inc.

Standard & Poor's 500, S&P500. The "500" is because the S&P 500 Index includes 500 US listed companies and covers industries such as finance, public utilities, transportation, etc., accounting for about 80% of the total market capitalization of the United States. Compared with the Dow Jones Industrial Average Index, the S&P 500 has the characteristics of wide sampling, strong representation, high accuracy, and good continuity. Which is generally considered as a more comprehensive response to the economic situation in the United States. The compose stocks of the index value more than $7.8 trillion, of which the index assets accounted for about

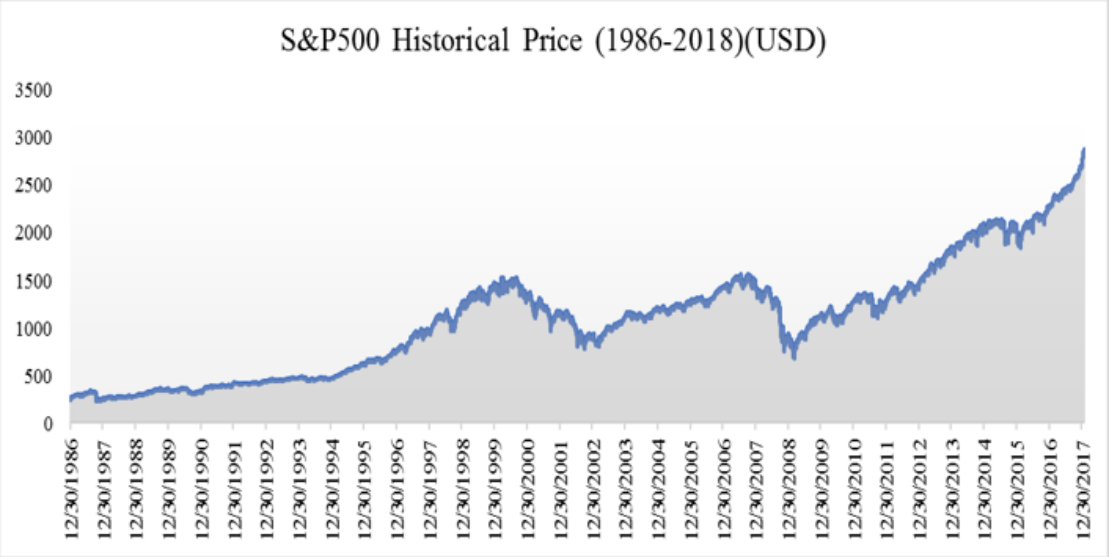
[2] Source: NYSE [Online]. Available on: https://www.nyse.com/trade

$2.2 trillion.

3.2.3 Development of The United States Stock Market

In past 30 years, US stock market experienced a fluctuating period, which include several ups and downs. We can see from the Figure 3.1, we will introduce the development, which focus on the extremum period.

Figure 3.1- S&P500 Historical Price



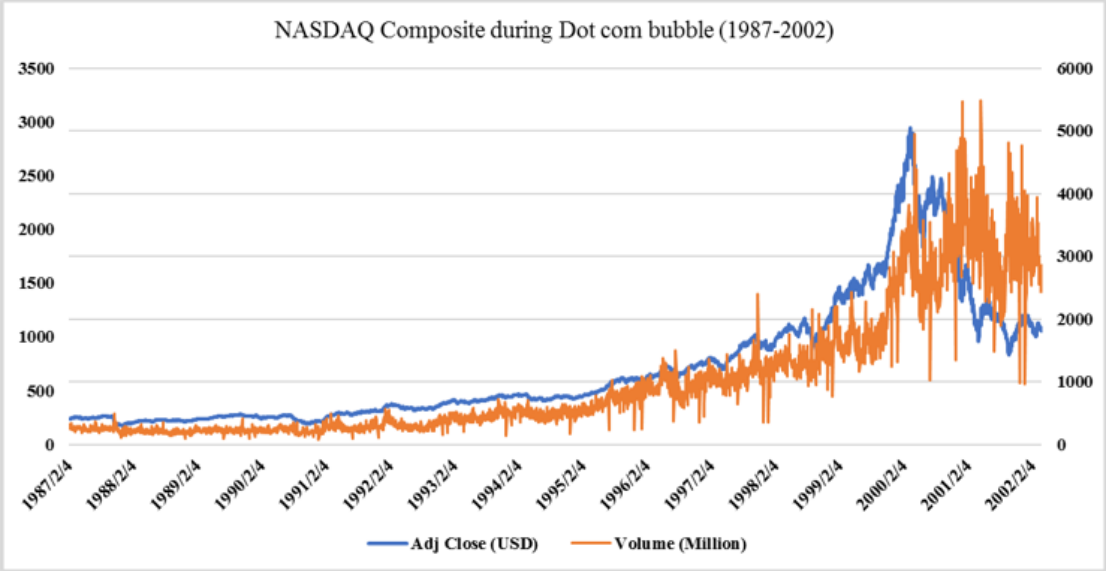
Source: https://finance.yahoo.com/, author

The collapse of the US stock market in 1987 was spectacular, accompanied with the collapse of the junk bond market, the crisis of the savings and loan associations mainly due to massive investments in junk bonds and the short-term deep end of commercial banks. After the stock market collapsed, the Fed acted quickly and announced that lowered interest rates, increased the money supply, provided emergency reserves to any banks that needed help, the public's confidence was maintained. In 1997, the US capital gains tax fell from 28% to 20%, which stimulated further rise in US stock market. In 1999, the Clinton Administration signed the "Financial Services Modernization Act of 1999," which stipulates that banks, securities and insurance companies can operate under one financial holding company. Therefore, the emergence of powerful universal banks and financial holding companies has saved transaction costs, which raising the operational efficiency and allocation efficiency of the entire financial system, as we well as supporting the prosperity of the US stock market. By the year 2000, the US stock market had risen continuously for 18 years. This is the longest period of prosperity in Wall Street history.

During this period, the NASDAQ market experienced a wave of spectacular investment boom. The NASDAQ Composite Index has rose suddenly and sharply. It can be seen from the

Figure 3.2 that from 1998 to 2000, the whole index increased about 256%. While during the same period, the S&P 500 only rose by 45%, we can see from Figure 3.1. However, since January 2000, the internet stocks have suddenly been sold off in large quantities and eventually triggered the collapse of the entire NASDAQ market. The NASDAQ Composite Index has fallen by 72%.

Figure 3.2-NASDAQ Composite Index during Dot-com bubble



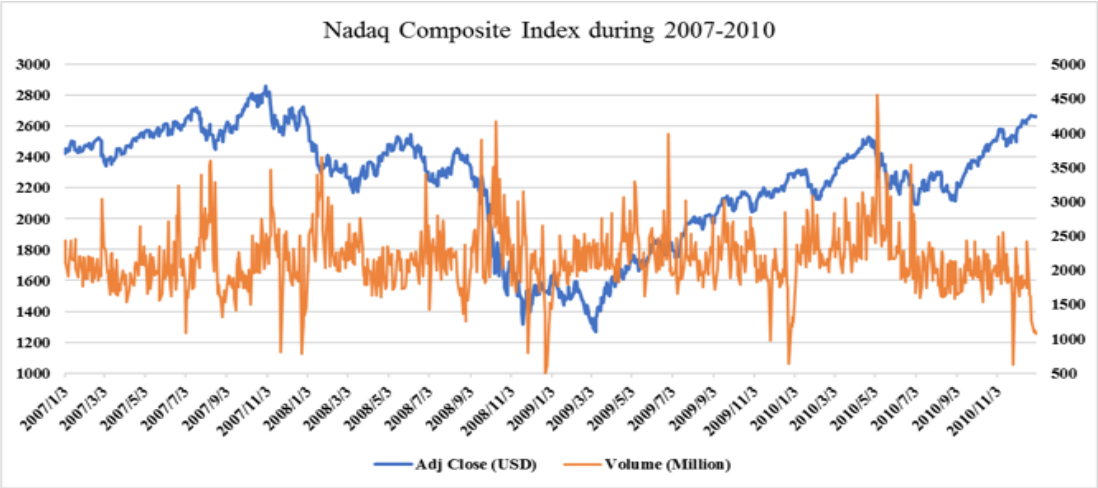
Source: https://finance.yahoo.com/, author

On October 9, 2002, the NASDAQ Composite Index closed at 1,114 points, which was a drop of nearly 78% from its historical high. During this period, listed companies are almost fall into losses, delisting, and even bankruptcies. Only a small number of dot-com companies, such as Amazon and eBay survived. The collapse of the dot-com bubble erased the market value of the technology company by about $5 trillion between March 2000 and October 2002. However, the terrorist attacked on September 11, 2001 led to further declines in the US stock market. Subsequently, the Bush administration and the US Congress took a series of measures to combat financial fraud and restore investor confidence. The Act proposed in 2002 imposes more strict specifications on the accounting and corporate governance of listed companies in the United State.

After September, 2011 event and dot-com bubble, the Fed lowered the nominal interest rate to an actual interest rate of zero. As a result, the return rate of traditional investment products such as treasury bonds was very low. In order to make a profit, US banks chose to issue a large amount of subprime loans, at the same time, derivatives such as CDO, CDS help banks to sell these subprime loans to other people. Banks have obtained additional funds from the financial market and have invested in the subprime loan business, which has doubled the

size of the business. Moreover, the credit rating of these derivatives has far underestimated the default rate and risks, resulting in a vicious circle. When any one of these links has default, it may lead to serious consequences. On April 2007, New Century Financial Corporation filed for bankruptcy protection because of bad debts of its operating subordinated debts. In August 2008, the stock prices of two major US mortgage lenders Fannie Mae and Freddie Mac plummeted, financial institutions which holding these two companies' bonds suffered large losses. On September 2008, investment banks on Wall Street are announced bankruptcy continuously. The global financial crisis started. It can be seen from the Figure 3.3 NASDAQ Composite Index shows the huge decline during the 2008.

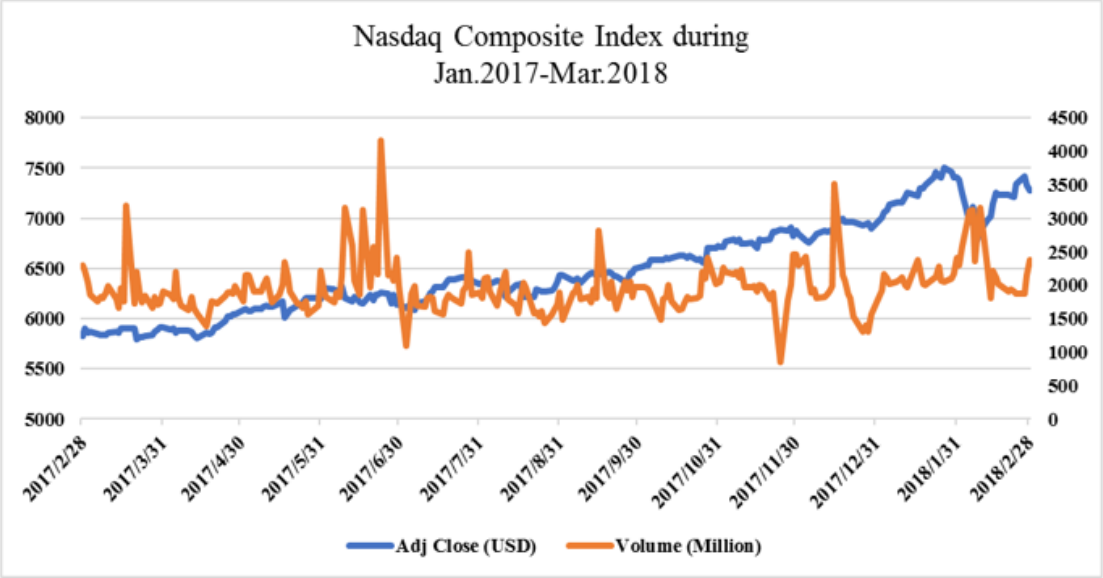
Figure 3.3-NASDAQ Composite Index during 2007-2010



Source: https://finance.yahoo.com/, author

In recent years, the US stocks have continued to create new high. After the arrival of the new US President Trump, the Trump tax reduction lead the stock market into a new expectation, and the US stock market created a bull market. One of Trump's campaign slogans is to reduce taxes. He announced reduce tax on listed companies from 35% to 20%. This reduction directly increases in net profit of listed companies. Trump may through this act to change US companies invested money abroad, which aim to avoid the high tax rates. Tax reform is expected to prompt some of these companies to withdraw large amounts of funds back the United States. Today's rise in stock prices not only reflects the current company's operations, but more importantly, the performance of listed companies after tax cuts will rise explosively, so US stocks have not peaked.

Figure 3.4- NASDAQ Composite Index during 2017-2018



Source: https://finance.yahoo.com/, author

However, the US stock market fell sharply on February 5, which is the largest daily drop since the 2008 financial crisis. This abnormally sharp decline has caused the outside world to panic. Moreover, this year is 10 years after financial Crisis of 2008. The whole global financial market need to worry if this will confirm the statement that the financial crisis will occur every ten years, after all, history will repeat itself.

3.3. Chinese Stock Market

The Chinese stock exchange market can be divided into floor exchange markets and OTC market based on the organizational form. There are four main floor exchange markets in China: Shanghai Stock Exchange, Shenzhen Stock Exchange, Hong Kong Stock Exchange, and Taiwan Stock Exchange. Among them, Shanghai Stock Exchange ranked first, next is Hong Kong Stock Exchange. Thus, we will mainly introduce these two markets, through knowing these two markets, we can have a generally understanding of the whole China stock market.

3.3.1 History of Chinese Stock Market

In 1891, the Shanghai Passenger Association was established, and changed its name to the Shanghai Stock Exchange in 1904. In 1920, the Shanghai Stock Commercial Association was reorganized to establish "Shanghai Chinese Businessmen Stock Exchange." In 1946, Shanghai Stock Exchange was officially opened, the listing company are mainly Chinese-based industrial and mining enterprises. In 1948, Tianjin Stock Exchange opened, and officially traded in 1949. Because of the war and political movements, Shanghai Stock Exchange and Tianjin Stock Exchange closed at that time. In 1990, stock market started *reform and opening*, the same year on November 26 Shanghai Stock Exchange established, on December 19 have done

business officially, supervised and managed by China Securities Regulatory Commission. The structure of Shanghai Stock Exchange is leading by General Assembly, Board of Governors, President Office and Board of Supervisors, through 30 departments effectively taking over the role as organizers and regulators of stock markets. In addition, Shanghai Stock Exchange has been shareholder of 21 companies.

Securities listed on SSE fall into four categories: stocks, bonds, funds and derivatives. Stocks are further divided into *Class A-Shares* and *Class B-Shares*. *A-shares* are priced in renminbi, issued in the face of Chinese citizens, and are listed on domestic stocks in China. A-shares are also known as RMB common stocks, outstanding shares, public shares, and common shares. Refers to common stocks that are registered in mainland China and listed in mainland China, buy and trade in RMB; *B-shares* - issued in US dollars and Hong Kong dollars, issued for overseas investors and listed in China. B-shares are also known as RMB special stocks. Refers to those special stocks that are registered in mainland China and listed in mainland China. Marking the face value in RMB can only be subscribed and traded in foreign currency. The place of registration and listing of B-share companies is in the territory. Only investors are overseas or in Hong Kong, China, Macau and Taiwan. On 1990, the first batch of 8 A-Shares was listed. In 1992, the first B-Share was listed. With the listing of a large number of large, leading and high-quality enterprises, SSE has begun playing its role as a barometer of the national economy. Bonds traded on SSE include treasury bonds (T-bonds), local government bonds, policy financial bonds, enterprise bonds, corporate bonds, asset backed securities, corporate bonds with detachable warrants, convertible corporate bonds, etc. Funds traded on SSE include ETFs, LOFs, closed-end funds and money market funds.

Hong Kong

Out of mainland of China, the longest history of stock exchange of China is Hong Kong Exchanges and Clearing Limited. Hong Kong as the *Special Administrative Region* of the People's Republic of China, has early experience on securities trading.

Securities trading in Hong Kong has a long history. It started as early as the beginning of Hong Kong in the 19th century. The earliest securities transactions in Hong Kong date back to 1866. Hong Kong's first stock exchange: Hong Kong Stockbrokers Association was established in 1891. In 1914, it was renamed the Hong Kong Stock Exchange. In 1921, Hong Kong established the second stock exchange, the Hong Kong Stockbrokers Association. In 1947, the two exchanges were merged into Hong Kong Stock Exchange Limited. On June 27,2000, the Hong Kong Stock Exchange was listed on the Stock Exchange. In December 2012, Hong

Kong Stock Exchange acquired the London Metal Exchange, the world's premier metal exchange since its founding in 1877. *H-shares*, first introduced in 1993, also known as state-owned shares, refers to the registered place of foreign shares in the Mainland China, listed in Hong Kong. The constraint is only institutional investors in Mainland China can invest in H-shares. Individual investors in Mainland China are not yet able to directly invest in H-shares. It will take time for individuals to invest in H shares directly. International capital investors can invest in H-shares.

Hong Kong Stock Exchange divided product into three parts: securities, derivatives and OTC derivatives. Securities listed in Hong Kong Stock Exchange [3] are mainly Equities, Exchange Traded Products, Derivative Warrants, Callable Bull/Bear Contracts, Real Estate Investment Trusts and Debt Securities; Derivatives include Equity Index, Single Stock Foreign Exchange, Interest Rate, and Commodities; OTC derivatives consist of swaps and forwards.

3.3.2 Indices of Chinese Stock Market

China's three major stock markets: Hong Kong, Shanghai and Shenzhen, all have individual stock indices, namely the Hang Seng Index, the Shanghai Composite Index and SZSE Composite Index, together with the Shanghai-Shenzhen 300 Index jointly prepared by the Shanghai and Shenzhen Stock Exchanges.

Since the Hong Kong stock market developed earlier, the oldest stock index in China is the Hang Seng Index. The Hang Seng Index is an important stock index in Asia except for the Nikkei 225 Index. *The Hang Seng Index* (HSI), the benchmark of the Hong Kong stock market, is one of the best-known indices in Asia and widely used by fund managers as their performance benchmark. The Hang Seng Index was established in 1964, currently includes 45 Hong Kong blue chip stocks, which are calculated using the free-floating market capitalization method. This reflects the overall trend of Hong Kong stock market prices and is calculated by Hang Seng Index Co., Ltd. The 45 constituent stocks of the Hang Seng Index collectively accounted for 67% of the market value of Hong Kong stocks. The Hang Seng Index is also divided into four categories to help investors distinguish between the various categories of stocks: Hang Seng Finance Sub-index, Hang Seng Utilities Sub-index, Hang Seng Properties Sub-index and Hang Seng Commerce & Industry Sub-index.

SSE Composite Index consists of all listed stocks (including A-shares and B-shares) on Shanghai Stock Exchange. The Index aims to reflect the overall performance of the Shanghai

[3] Source: HKEX [Online]. Available on: https://www.hkex.com.hk/?sc_lang=en#

stock market. The Shanghai Composite Index was formally used on July 15, 1991. It was based on the closing price of December 19, 1990, and the index of the day was set at 100 points. As the trading volume of the Shanghai Stock Exchange increases, its position in the international financial community has also increased. In addition, SSE 180 Index is also an index in Shanghai Stock Exchange, which consists of the 180 largest and most liquid A-share stocks listed on Shanghai Stock Exchange. The Index aims to reflect the performance of the Shanghai blue chips. SSE 50 is an index that officially select 50 stocks which are large-scale, good liquidity of the most representative sample in Shanghai securities market, to synthesize reflect the overall quality of Shanghai securities market to through the most influential group.

The *Shanghai-Shenzhen 300* Stock Index (CSI 300) includes 300 representative A-shares on the Shanghai and Shenzhen stock exchanges, which account for 70% of the market value of the two stock exchanges. The benchmark day for the CSI 300 Index is December 31, 2004, and 1000 points are the starting point for the index. The index is calculated using the adjusted equity weighting method. The Shanghai-Shenzhen 300 Index is also the subject of the Shanghai-Shenzhen 300 Index Futures, which is traded on the China Financial Futures Exchange.

3.3.3 Development of Chinese Stock Market

Compared to the US stock market, China mainland stock market started later and hard to reflect to the international event immediately before join WTO, while Hong Kong stock market still shows more fluctuating development.

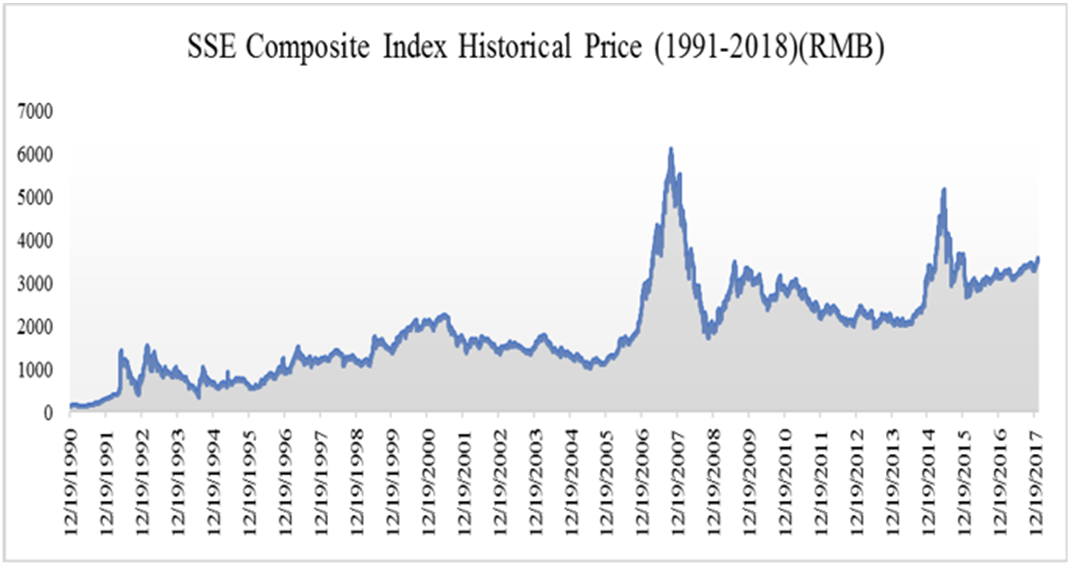
Figure 3.5-Hang Seng Index Historical Price during 1986-2018

Source: https://finance.yahoo.com/, author

China mainland stock market has first bull market in 1993 because of the influence of

the government macroeconomic tightening policy to curb economic overheating, at the same time, Hong Kong has experienced huge shocks when Morgan Stanley drove the international funds into Hong Kong with madness, it also promoted the internationalization of the Hong Kong stock market. On July 1,1997, Hong Kong was returned to the Motherland China. Just a few days, the Asian financial crisis swept Thailand and the devaluation of the Thai baht led to the financial crisis in Southeast Asia, Hong Kong stock market are fell down sharply, after hitting the highest point, it began to fall rapidly. We can see from the Figure 3.5 and 3.6, during southeast Asia Financial crisis, Hong Kong are more impacted than China mainland, Hong Kong's financial system is at risk of collapse, therefore, China mainland had more economic support to Hong Kong at that time. The Chinese mainland economy is developing rapidly. Relying on the economic advantages of foreign trade and the strong productivity and commodity demand of China mainland, Hong Kong opening is free and Hong Kong economy achieves sustained high growth coupled with the expectation of Hong Kong stock through-train. A long bull market started from 2003 to 2006.

Figure 3.6- SSE Composite Index Historical Price



Source: https://finance.yahoo.com/, author

However, the global financial crisis triggered by the US subprime mortgage crisis in 2008 made A-shares go down all the way to complete the most brutal bear market in China stock market, although the impacts were not serious, together with the natural disaster of China in 2008, the stock market in China still fall in to a trough. This also shows the drawbacks of international economic integration. During 2015-2016, we can see a decline of SSE, China mainland stock market experienced a sharp decline in the short term. Since the beginning of 2015, both Shanghai and Shenzhen stock market have continued to rise and out of control. The

SSE composite index reached a high of 5178.19 on June 12 and then fell sharply. The reason is that production slumped for the first time since 2015 due to the sluggish manufacturing industry. After that, the China Securities Regulatory Commission (CSRC) helped the market recover and the stock market resumed a steady increase. Recently years, compared with the global stock market in 2017 such as three major indices of US have risen by more than 20%, China mainland stock market is rather inferior, and it is taking a steady rise. However, the Hang Seng Index has risen by 1.99%, reach a 10-year new highs of closing price. In 2018, the value of the Chinese mainland stock market will rise steadily with the gradual improvement of the economic situation. For example, the upgrading of the consumption structure, the increase in environmental protection, and the rise of emerging industries will all bring more opportunities to the mainland stock market.

3.4 Japanese Stock Market

As one of the world's economic power, Japan's stock market is also among the best. By 2017, Tokyo Stock Exchange was ranked fourth in the world with the market capitalization of $4.5 trillion. Tokyo Stock Exchange, Osaka Stock Exchange and Nagoya Stock Exchange, Japan's three stock exchanges tied for the top three market size, at the same time as the most important economic centers of Japan.

3.4.1 History of Japanese Stock Market

Japan's stock market was primarily based on bond trading. By the late 1880s, with the rise of modern Japanese companies, stock trading has increased substantially. However, prior to the Second World War, Japan's stock market was not well-developed. This was due to the military controls caused by militarism. As a result, the stock exchanges were subject to various restrictions, the transaction scale was drastically reduced, and the stock market play a decline role of the Japanese economy. In 1945, the Japanese stock market gradually ceased trading. After the Second World War, in order to revitalize the Japanese economy, the Japanese government issued a new law on stock transactions emulate to the United States. In 1949, the Tokyo Stock Exchange was officially established again, and the other eight stock exchanges were also successively opened. At the same time, with the collapse of the consortium and the dissolution of securities institutions, individual investors have rapidly developed. In addition, Japan has implemented a policy of financial and securities liberalization that has greatly stimulated and promoted the development of the Japanese stock market.

Tokyo Stock Exchange is the fourth largest stock exchange in the world, but it is not a big international financial center. The overseas companies listed on the Tokyo Stock Exchange

are quite small, basically Japanese companies, while New York and other international stock exchanges, there is also a considerable number of foreign companies. In 2000, the Hiroshima Stock Exchange and the Niigata Stock Exchange merged with the Tokyo Stock Exchange. On November 20, 2012, the Tokyo Stock Exchange and the Osaka Exchange jointly held a news conference to announce that the two exchanges will merge and form the Japan Exchange Group (JPX) on January 1, 2013. JPX operates financial instruments exchange markets to provide market users with reliable venues for trading listed securities and derivatives instruments. In addition to providing market infrastructure and market data, JPX also provides clearing and settlement services through a central counterparty and conducts trading oversight to maintain the integrity of the markets.

The organizational structure of Tokyo Stock Exchange is General Meeting of Shareholders, Board of directors and Advisory Committees with 11 departments. Tokyo Stock Exchange remains the largest Stock Exchange in Asia with a total market capitalization of $5.1 trillion in the year ending 2016, an increase of 3.4% compared to 2015.

3.4.2 Indices of Japanese Stock Market

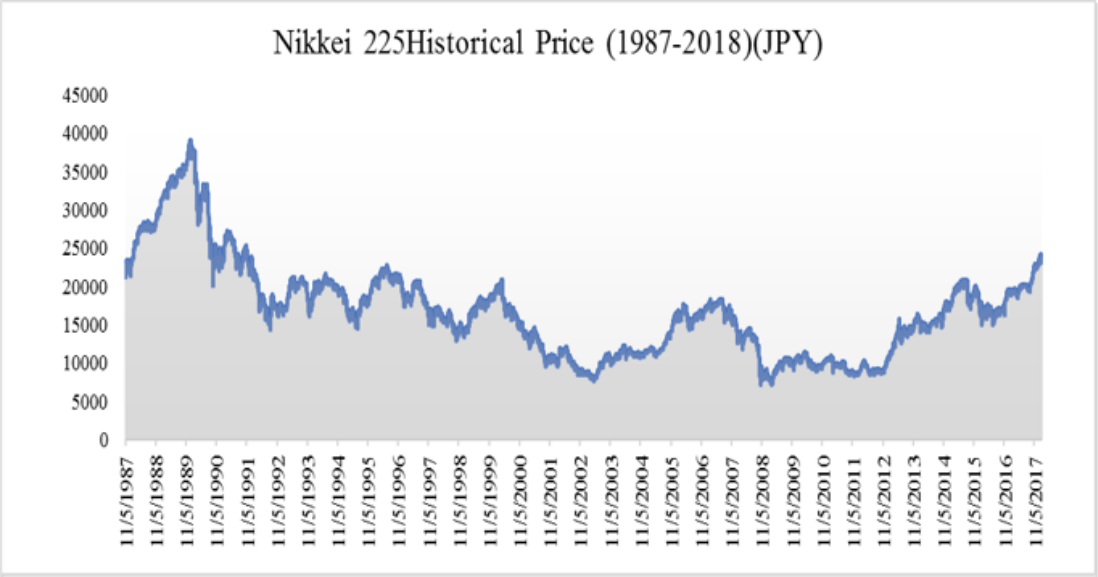
There are two major stock price indices in Japan. One is the *Nikkei 225*, which including the average of 225 stocks of the Nikkei. All are based on the first stock listed on the Tokyo Stock Exchange. The other is the Tokyo Stock Price Index, which is based on the first section of the Tokyo Stock Exchange.

Nikkei 225 is Japan's longest history index. It was compiled on September 7, 1950. The index value can be traced back to May 16, 1949, and it is the most popular stock price index in Japan. The index selects 225 most representative stocks from the stocks listed on the Tokyo Stock Exchange. The method of calculation is the same as that of the DJIA. Japan's television or newspapers will certainly use the index when broadcasting situation of the Japanese stock market. The Nikkei 225 is used by many domestic and foreign financial products. The Nikkei 225 is not limited to Japan. It is also the most widely used index in foreign financial products. The liquidity of the related products of the index is a good indicator of investor price discovery. *Tokyo Stock Price Index* (TOPIX) is a free-float adjusted market capitalization-weighted index that is calculated based on all the domestic common stocks listed on the Tokyo Stock Exchange 1st Section. This is a measure of the overall trend in the stock market and is used as a benchmark for investment in japan stocks. Otherwise, *JPX-Nikkei 400* is composed of companies with high appeal for investors, which meet requirements of global investment standards, such as efficient use of capital and investor-focused management perspectives.

3.4.3 Development of Japanese Stock Market

At the end of the 1980s, Japan was ranked in the forefront of the world's economic power by its powerful automobile industry. Be influenced by Japan's economic prosperity and the stock market's increase, Japanese households all joined the stock market. At the end of 1989, the Japanese stock market reached a historic high level. The Nikkei 225 rushed to 38915 points. At that time, a large number of US investment banks followed the example of Goldman Sachs and sold their stock index options bought from the Japanese insurance industry to other kingdoms. As a result, the Japanese stock market began an irresistible plunge, until April 2003, the lowest fell to 7607 points, it can be seen in Figure 3.7. The cumulative decline of up to 63.24% has created the largest decline in the history of the Japanese stock market.

Figure 3.7-Nikkei 225 Historical Price during 1987-2018



Source: https://finance.yahoo.com/, author

Just a few years, Japan started recovery from last stock shock, while US subprime mortgage crisis gave the Japan stock market a huge hit, Nikkei 225 had a big decline to 7054 points, which was the new low of past years.

In the years that followed, Japan has been constantly recovering from the depressed economy, despite in early 2016, the Bank of Japan introduced a negative interest rate policy, a major earthquake in Kumamoto, such kinds of unexpected incidents continued, causing the market to fluctuate continuously, Japan stock market entered a steady growth period.

3.5 German Stock Market

Germany as a highly developed country in Europe plays an important role in world economic. From Brexit, Germany is becoming new financial center of the Europe. There are mainly 8 stock exchange in Germany, among them, Frankfurt Stock Exchange is second in Europe. It is also the largest stock exchange in Germany.

3.5.1 History of German Stock Market

Frankfurt Stock Exchange established in 1585, the first stock IPO in Frankfurt in 1820. In 1993, during long history of Frankfurt Stock Exchange, which can be seen a watershed. Prior to 1993, the companies in Frankfurt, and associated institutions dealt with securities transactions independent and did not have unified management and rules. In order to meet the needs of the new trend, especially to enhance the position of Frankfurt in the same industry of the world, the Deutsche Boerse Group was formally established based on the stock exchange of Frankfurt Stock Exchange in 1993. Frankfurt Stock Exchange is offering both the *Xetra* (securities electronic trading platform) and the traditional floor trading.

Frankfurt Stock Exchange provides trading in Equities, Bonds, ETF/ETP, Funds and Commodities. The international equity-market is transparent by indices as the Dow Jones Industrial, Nikkei or the NASDAQ 100.

As the end of 2016, Frankfurt Stock Exchange is the 2nd largest stock exchange in European stock market with 1.7 trillion dollars, an increase of 1.0% compared to 2015.

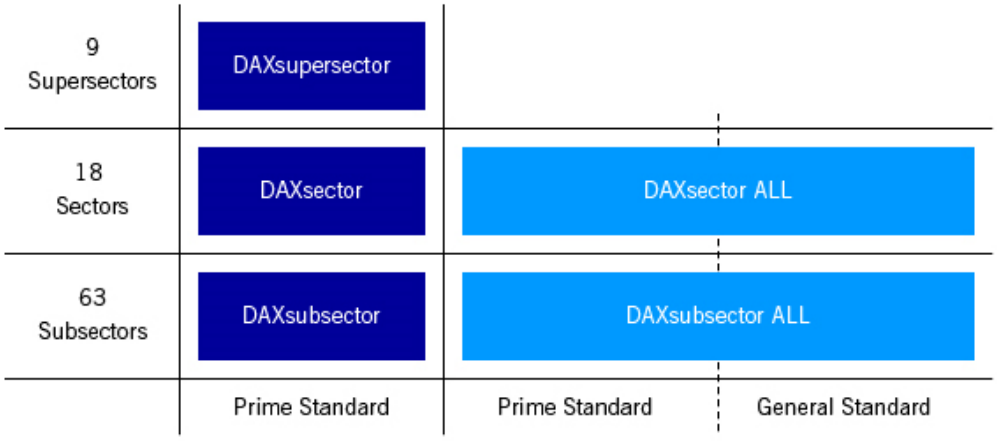
3.5.2 Indices of German Stock Market

The most important German indices are the DAX, TecDAX, MDAX, SDAX and DivDAX. These indices are Deutsche Boerse Group selection indices based exclusively on companies listed in the Prime Standard segment. GEX is the indicator for the performance of publicly-listed SMEs. Family-run companies are tracked in the DAXplus Family 30, which functions as a “family index” for the 30 largest family-run companies, by market capitalization. Again, the condition for inclusion in these two selection indices is a listing in the Prime Standard.

Sector indices differentiate between the listed corporations and reflect trends in individual sectors. These sector indices help a comparison of the performance of providers of similar products or services. They are subdivided into 18 sectors and are compiled in nine super-sectors. Companies are assigned to sectors on the basis of classification by 63 subsectors. All

companies that are admitted to the Prime Standard or General Standard are included in a sector index and subsector index.

Table 3.1- Sector of Indices in Frankfurt Stock Exchange



Source: http://en.boerse-frankfurt.de/

DAX, the most important German index, is simultaneous the image for the German-Blue chip-equities. They are equities with a particularly high exchange value, whose company enjoy a high recognition.[4]

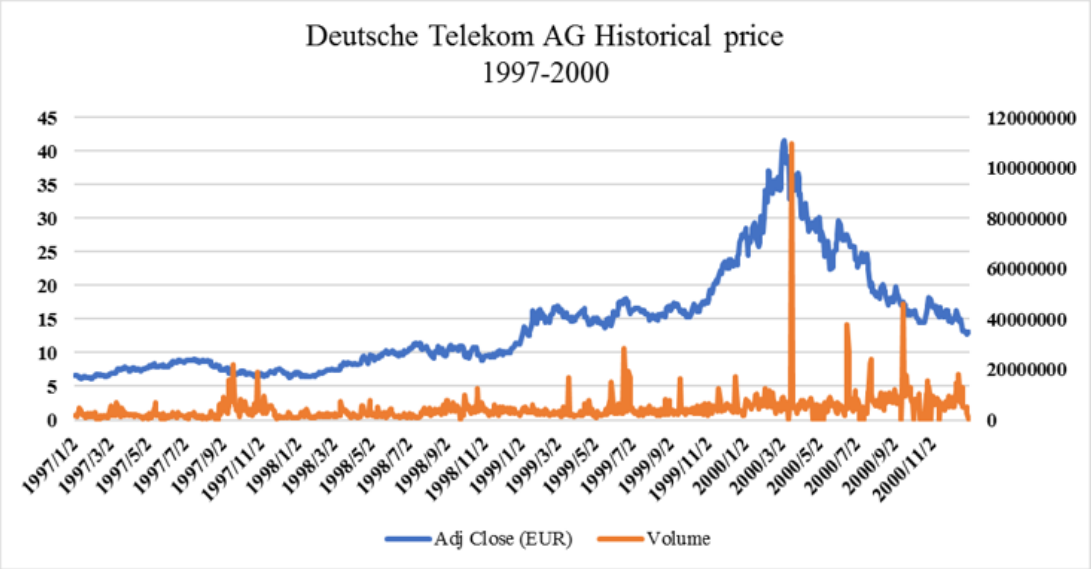
3.5.3 Development of German Stock Market

The German stock research institute has published a survey report showing that most of the Germans are reluctant to buy stocks. The reason for this must mention the stock market crash in 2000. From 1996 to 2000, under the push of the privatization reform of the federal government, the German people started interested in investing stocks. In 1997, Deutsche Telekom was listed on the Frankfurt Stock Exchange. Many people frantically bought shares of Deutsche Telekom because of advertising. From 1996 to 2000, the share price of Deutsche Telekom rose by more than 7 times per share to a level equivalent to 41.7 euros per share. However, since 2000, the share price of high-tech stocks in the world has declined due to the dot-com bubble. The DAX index has dropped from 8136 points to 2188 points. In less than two years, Deutsche Telekom's share price has dropped from a high position to less than 10 euros per share.

After followed years, Germans were willing to save money into the saving account, which only with low interest rate, rather than to invest. Due to the financial crisis in 2008, Germany also deeply affected by the global depressed economy, in 2009, the German economy has been in the process of recovery.

[4] Source: About equities. [online] Available on: http://en.boerse-frankfurt.de/equities

Figure 3.8- Deutsche Telekom AG Historical Price during 1997-2000



Source: https://finance.yahoo.com/, author

Figure 3.9- DAX Historical Price during 1987-2018

Source: https://finance.yahoo.com/, author

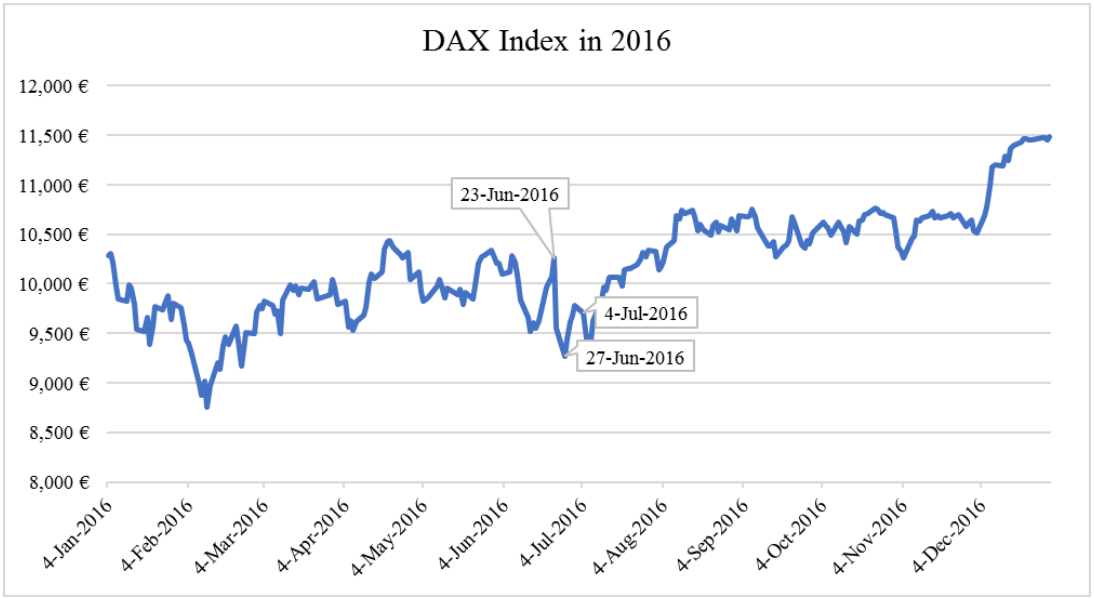
On the one hand, Germany's core sectors represented by automobiles and machinery maintain a strong leading edge. While started from Greece, European were covered by the European debt crisis, although the stock market more or less be influenced, we can see from the Figure 3.9, since 2011, the DAX rose by about 30%, bringing great returns to investors. The reason of the reversed from European debt crisis is because of devaluation of the euro caused by the European debt crisis has increased the international competitiveness of German exports and has played an important role in the export-oriented German economy.

Till 2015, The slump in the Chinese stock market caused by the downturn in China's

manufacturing industry also affected several export-oriented countries, including Germany, we can see from the Figure 3.9, the DAX fell by nearly 3%, it can be seen that the integration of the world economy and the development of China's economy will also affect the changes in the global stock market.

On June 24, 2016. The United Kingdom voted in favor of leaving the European Union, this unexpected result caused the European financial market to suffer a severe impact. The major European stock indices including the DAX Index fell sharply. The reason why Germany affected by Brexit is because of the United Kingdom is the second only to Germany from the perspective of economic aggregates and foreign trade. After Brexit, Germany may loss an important partner in Europe, which may cause Germany suffering an economic loss. Meanwhile, the Brexit will cause Germany to make more contributions to the European Union and take more share of funding. Generally, Brexit still brought a significant influence on the European financial market, we can see through the Figure 3.10 that the DAX index fall quickly while recovered after four days later, compared with the European debt crisis, the impact of Brexit can be controlled to a certain extent.

Figure 3.10- The DAX Index Historical Price in 2016



Source: https://finance.yahoo.com/, author

In recent years, due to the inflow of large amounts of capital and the rising stock market not only in Germany, also strong performance of the world economy, investors' risk tolerance has increased, German stock market will input more new vitality.

4 Assessment of Long-Term Investing in Stock Markets

In this chapter, we will assess long-term investing in main stock markets of the world, with help of moving average method, volatility analysis and econometrics analysis. The objective is to find the relationships and differences among different stock markets and to explain results of investing during long time horizon.

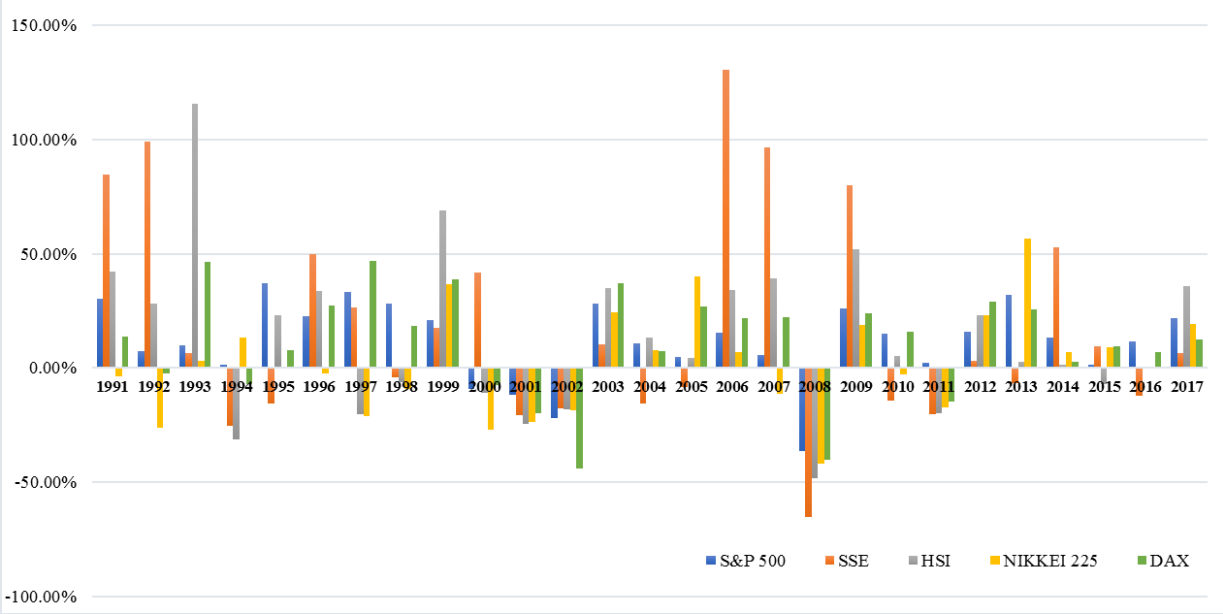
4.1 Moving Average Method

The Moving Average (MA) is a simple stock market analysis tool that uses historical prices to build a constantly updated reference. In this part, we will use moving average method to help us know more about each stock market in long-term investment.

4.1.1 Average Yield of Stock Indices in Selected Markets

To prove the efficiency of long-term investing in stock markets, we calculated average yield of stock indices in selected markets, in addition, we started from one-year average, then every 5-year moving till every 25-year average. The result shows very clearly evidence that long-term investing is more profitability than short-term investing. Let's have a look of the result from one-year average.

Figure 4.1.1- Yearly Average Yield of Stock Indices



Source: Author

From the Figure 4.1.1, blue represents the S&P 500, orange represents the SSE Composite Index, gray represents the Hang Seng Index, yellow represents the Nikkei 225 and green represents the DAX. We can obviously see the negative return of stock indices exist in one-year average. The lowest return -65.39% was the SSE Composite Index in 2008, while the

highest return 130.43% was the SSE Composite Index in 2006. Following table shows the extreme return in each stock index.

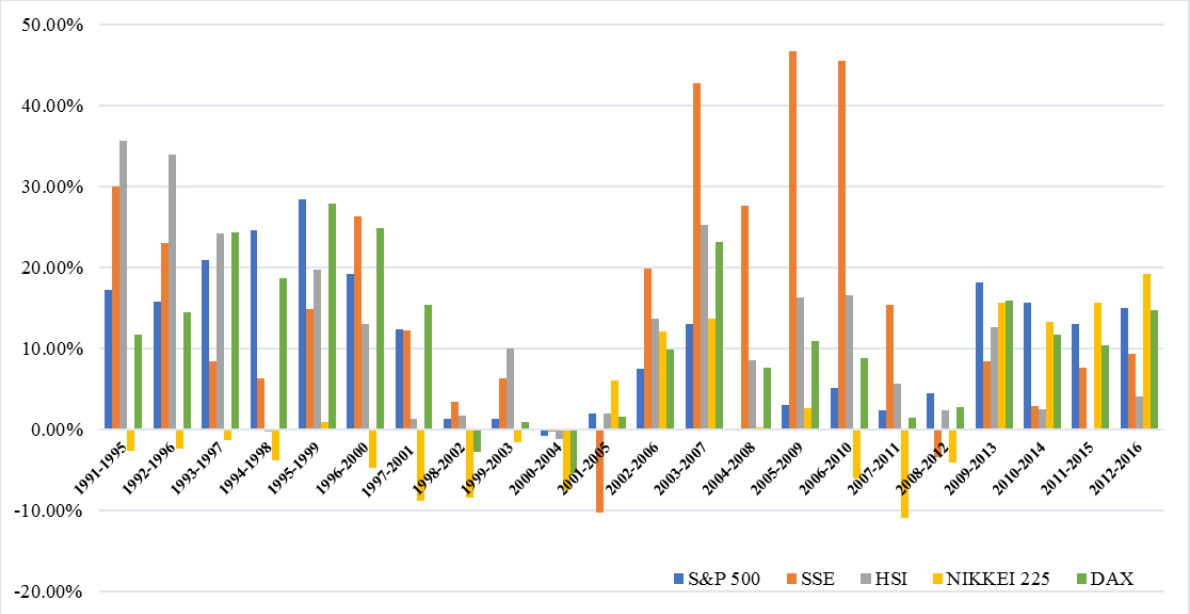
Table 4.1.1- Extreme return based on one-year average

	S&P 500	SSE	HSI	Nikkei 225	DAX
Maximum return	37.20%	130.43%	115.67%	56.72%	46.67%
Minimum return	-36.55%	-65.39%	-48.27%	-42.12%	-31.87%

Source: Author

The difference of extreme return of each stock index shows unstable of the short-term investing. And the frequency of negative return happened most in SSE Composite Index, while least in S&P 500. If investors are interested in short-term investment, better choice among these stock market can be the United States. Next, we can see the result of 5-year average yield.

Figure 4.1.2- 5- year Average Yield of Stock Indices



Source: Author

Compared to one-year average, we can see the negative return in Figure 4.1.2 reduced, and can see the most obviously color is yellow, which represents Nikkei 225. The minimum average return among these stock indices was Nikkei 225 from 2001-2011, and the maximum average return was SSE in 2005-2009.

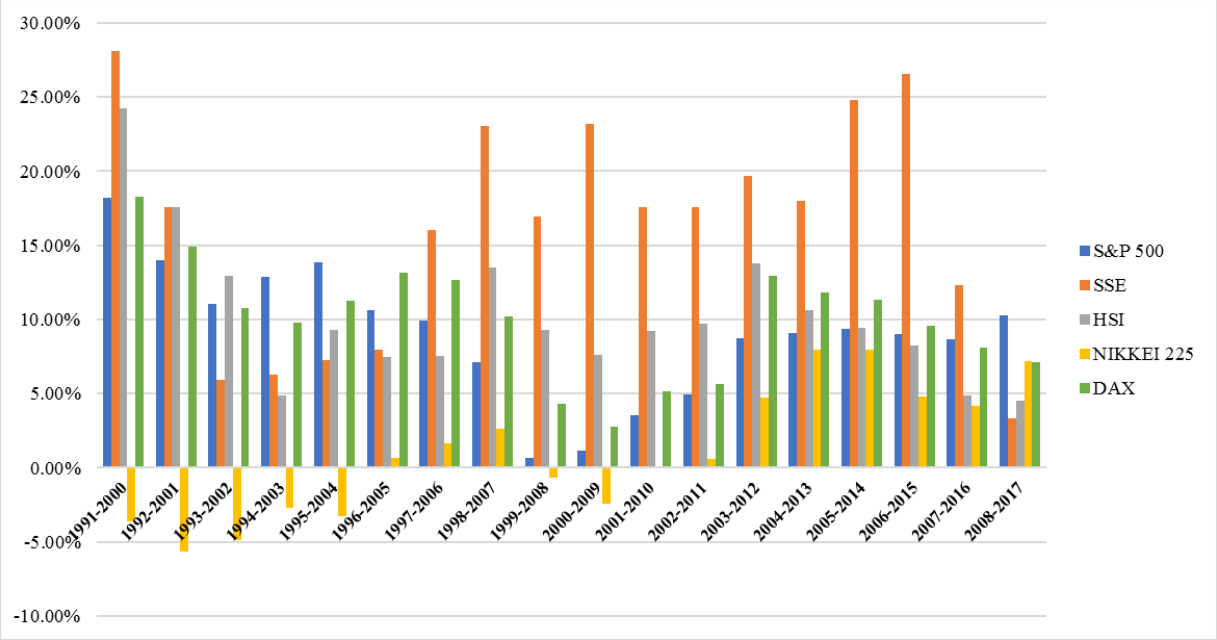
Table 4.1.2- Extreme value of based on five-year average

	S&P 500	SSE	HSI	Nikkei 225	DAX
Maximum return	28.44%	46.67%	35.59%	19.26%	27.87%
Minimum return	-0.75%	-10.32%	-1.13%	-10.91%	-5.37%

Source: Author

As we mention before, the SSE Composite Index has the lowest yearly average return in 2006, while has the highest 5-year average return during 2005-2009, which proved that investor more profitability if they invest in longer term than shorter term and can avoid level of risk. In addition, during 5-year average, the S&P 500 and Hang Seng Index had almost no minimum return, which showed better performance than shorter term.

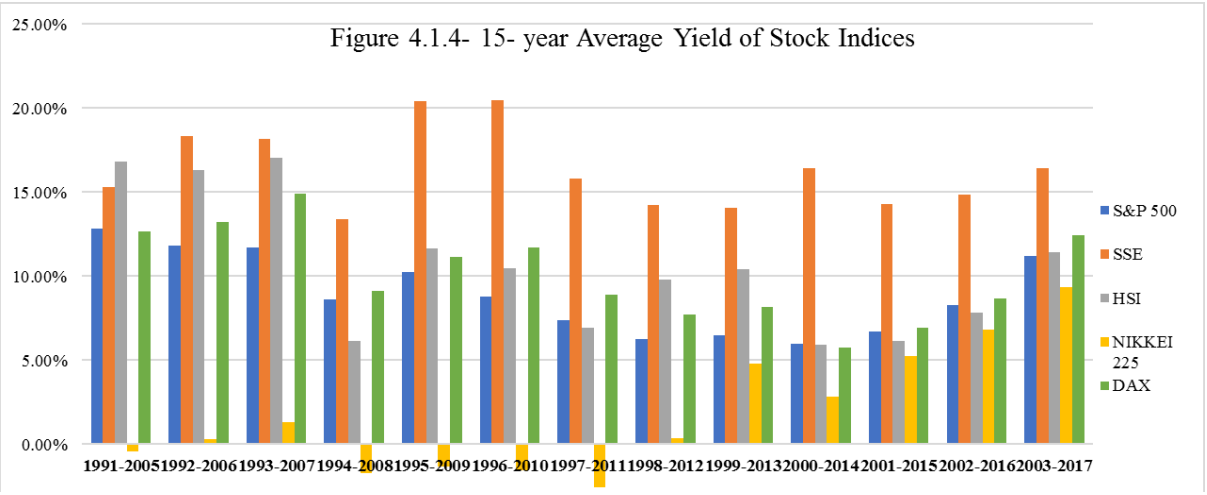
Figure 4.1.3- 10- year Average Yield of Stock Indices



Source: Author

Figure 4.1.3 shows the result of 10-year average yield of stock indices, except Nikkei 225, others stock indices all had positive return and the highest return was still SSE from 1991-2000 of 28.1%. However, the Nikkei 225 has a better profitability in recently year although had lowest return at -5.64% from 1992-2001. Compared to one-year and 5-year average, 10-year average proved more evidence of better performance in long-term investing.

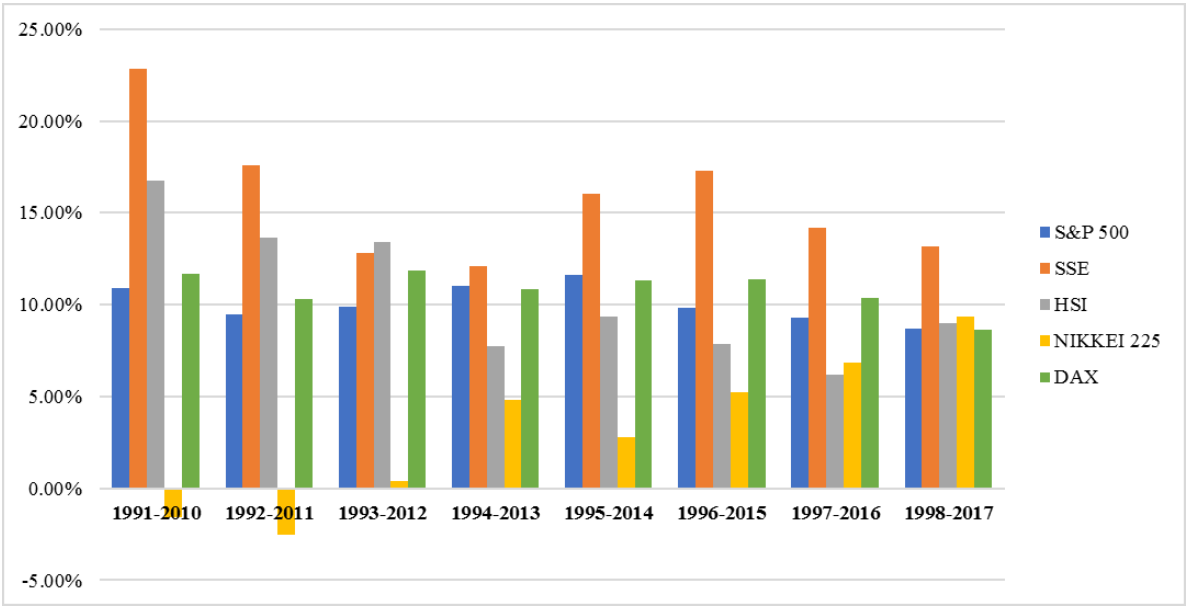
Figure 4.1.4- 15- year Average Yield of Stock Indices



Source: Author

The average in 15 year shows more stable and profitability in stock indices. Especially in Figure 4.1.4, the SSE Composite Index shows a very stable and high profitability yield return and the DAX also had a stable performance in 15-year average. The only negative average return is Nikkei 225, which can see Japan has a bad situation in stock market during past years no matter the invest period is short or long.

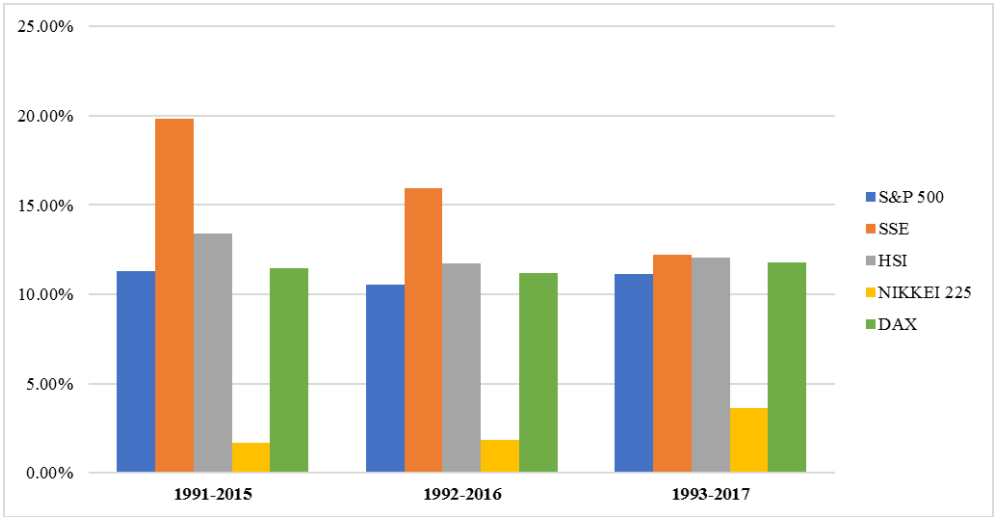
Figure 4.1.5- 20- year Average Yield of Stock Indices



Source: Author

Better performance can be seen at Figure 4.1.5, the 20-year average yield among stock markets. S&P 500 and DAX had very stable and relatively high return, SSE had very high profitability while the stability is less than other indices. While Nikkei 225 still had negative return at -2.52% from 1992-2011.

Figure 4.1.6- 25- year Average Yield of Stock Indices



Source: Author

From Figure 4.1.6, all stock indices have positive return in 25-year average, although Nikkei 225 has lowest return. In general, Nikkei 225 shows a relatively low profitability among these stock indices; However, in Japan, the inflation rate has been very low since 1980 and has repeatedly entered deflation. As deflation leaded to a low supply of money, social purchasing power decreasing and the stock market fall into a depressed state.

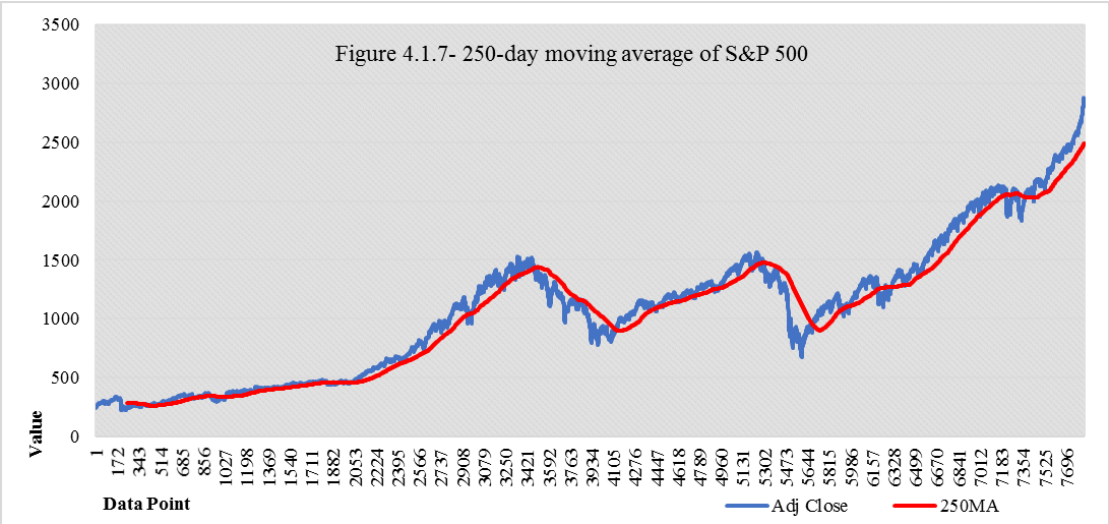
While the SSE Composite Index has relatively high profitability in long-term investing. As we know China mainland stock market started late and immature, the reason why the profitability in long-term can higher than other mature markets can consider of inflation in China. However, the real inflation rate in China actually higher than officially announcement due to incomplete calculation method and huge population in China. The highest inflation rate in China was at 1994 about 24.10%, high inflation in China stimulated the stock market to some extent.

In addition, S&P 500 and the DAX had very stable and relatively high return in long-term. We still can conclude that in long-term investing can have more stable return and more profitability than in short-term.

4.1.2 The United States Stock Market

Figure 4.1.7 is a simple moving average on the S&P 500 from 1987-2018. The blue line represents the adjusted closing price of the index, the red line represents a 250-day moving average. Here we choose 250-day moving average, because one trading year usually has 250 days, this period is particularly suitable for the long-term investment.

In general, the United States has very long bull market, we can also see from the Figure 4.1.7, which shows a very steadily growing trend of S&P 500. When 250-day moving average

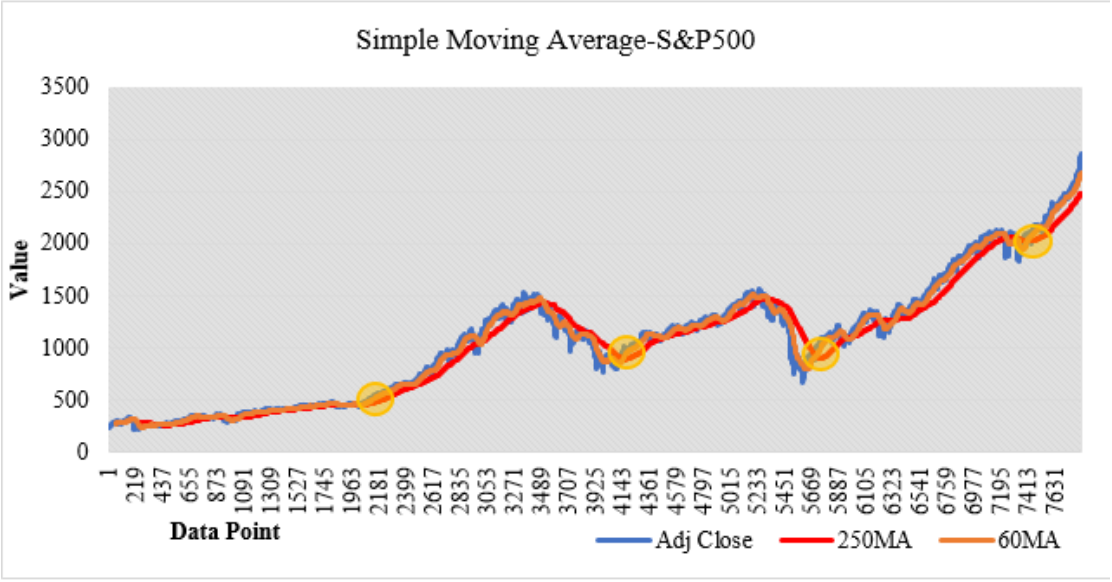


Source: https://finance.yahoo.com/, author

smooth the adjusted closing price, we can see the overall trend line is increasing, although it experienced several times of bear market as well, but the durations were obviously shorter.

Through the cross point of 60-day moving average and 250-day moving average, we can distinguish if the point is Golden Cross or Death Cross. *Golden Cross* means that the rising short-term moving average crosses above long-term moving average and the stock price will continue to rise and the market is optimistic. *Death Cross* refers to the short-term moving average cross below the long-term moving average, indicating that the stock price will fall continuously and the market is bearish. Because the moving average is only a smooth trend line, it has lag when reflecting the abrupt change of the stock price, no matter gold cross or death cross, it can only serve as a reference. Golden Cross shows as following figure.

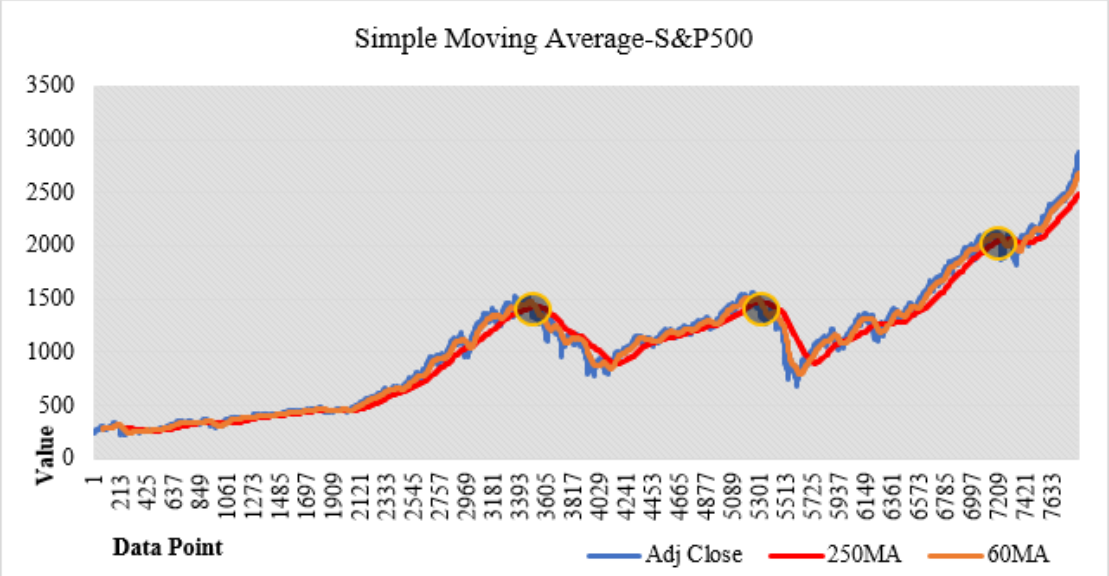
Figure 4.1.8- Bullish crossover of the S&P 500



Source: https://finance.yahoo.com/, author

As we can see from the Figure 4.1.8, every time after shorter moving average cross above longer moving average cross, both shorter and longer moving average will parallel to the adjusted closing price, which indicates the increase in the market is very large, it is good signal of buying opportunity.

Figure 4.1.9- Bearish crossover of the S&P 500



Source: https://finance.yahoo.com/, author

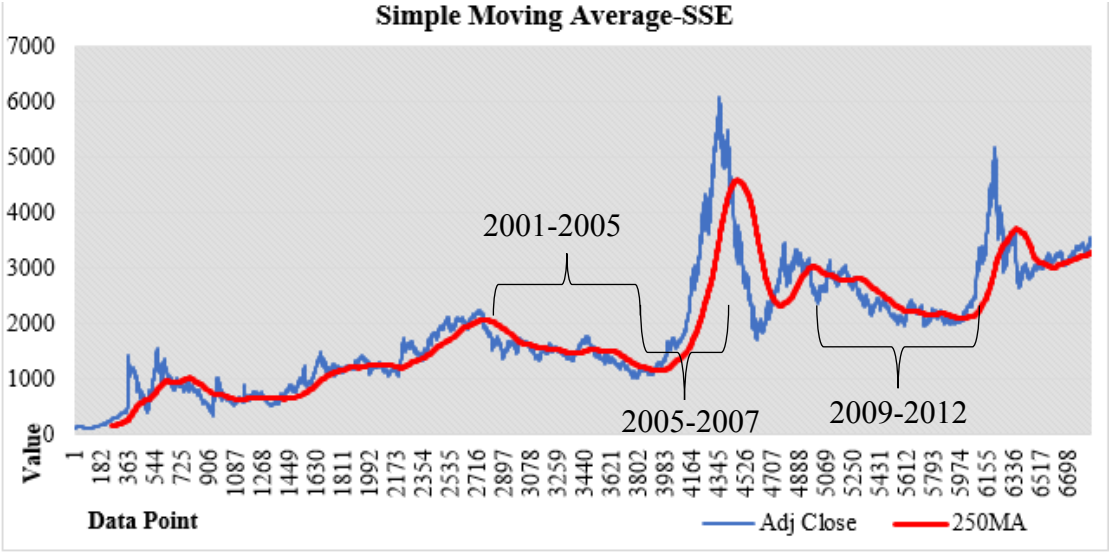
From the Figure 4.1.9, we can see the trend lines are smooth, we can't find too much Death Cross, the duration of the bear market is shorter than bull market obviously.

In general, we can say the United States stock market has more bull market than bear market, and the fluctuation is less than other markets. Recently year, the adjusted closing price of S&P 500 is increasing and reach new high continuously, while in long-run, as we can see from the Figure 4.1.9, in our opinion, the time of the bear market will come, because the history is always repeat itself.

4.1.3 Chinese Stock Market

Since Hong Kong is a Special Administrative Region of China, we will analyze two markets separately. Figure 4.1.10 is a simple moving average on the SSE Composite Index from 1990-2018. The blue line represents the adjusted closing price of the index, the red line represents a 250-day moving average. Here we choose 250-day moving average, because one trading year usually has 250 days, this period is particularly suitable for the long-term investment.

Figure 4.1.10- 250-day moving average of the SSE Composite Index

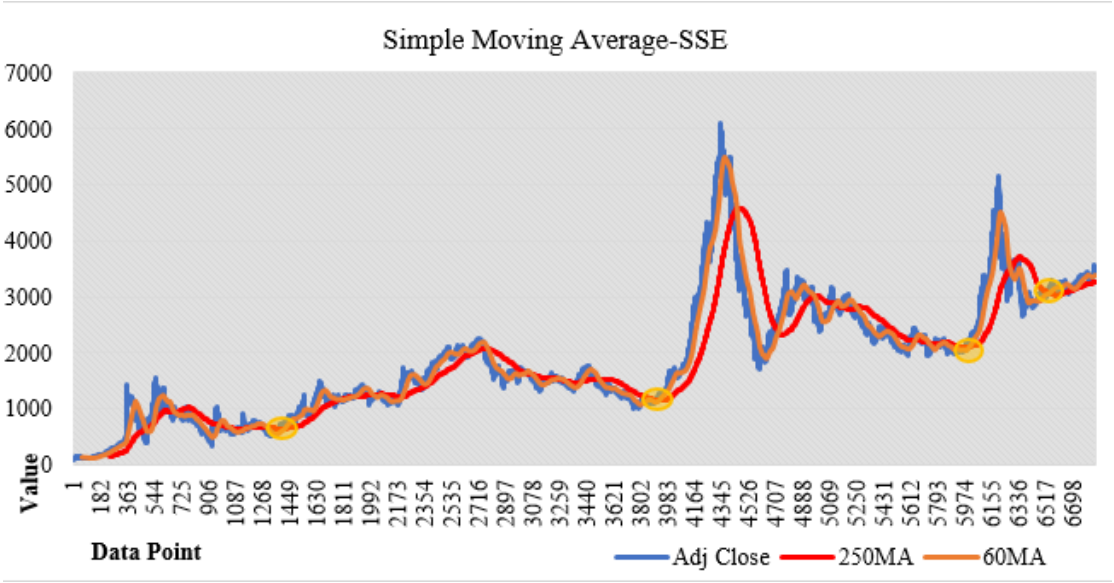


Source: https://finance.yahoo.com/, author

In the figure above, we can see that the moving average smooth the adjusted closing price and exists lag. During several years in bear market from 2001-2005, in 2005 China started the seventh bull market, and in 2007, SSE reached a new high of 6,124 points, a total increase of 513.49%. While during to the global financial crisis, and manufacturing industry fall into downturn in China, trend has been moving lower since early 2008. The adjusted closing price of the SSE Composite Index fell below the 250-day moving average in 2009 and continued downward till 2012, which is the longest bear market of China stock market. From the Figure, we can see when adjusted closes cross below the 250-day moving average, we may sell stock at that given signal, such as the cross point in 2001, while when adjusted closes cross above moving average, it is the signal to buy.

Next, we add a shorter moving average, 60-day moving average. In Figure 4.1.11, the orange line represents the 60-day moving average, compared to the 250-day moving average, we can see the short-term trend is more reactionary to the market, it moves a little bit faster with the overall price changes.

Figure 4.1.11- Bullish crossover of the SSE Composite Index

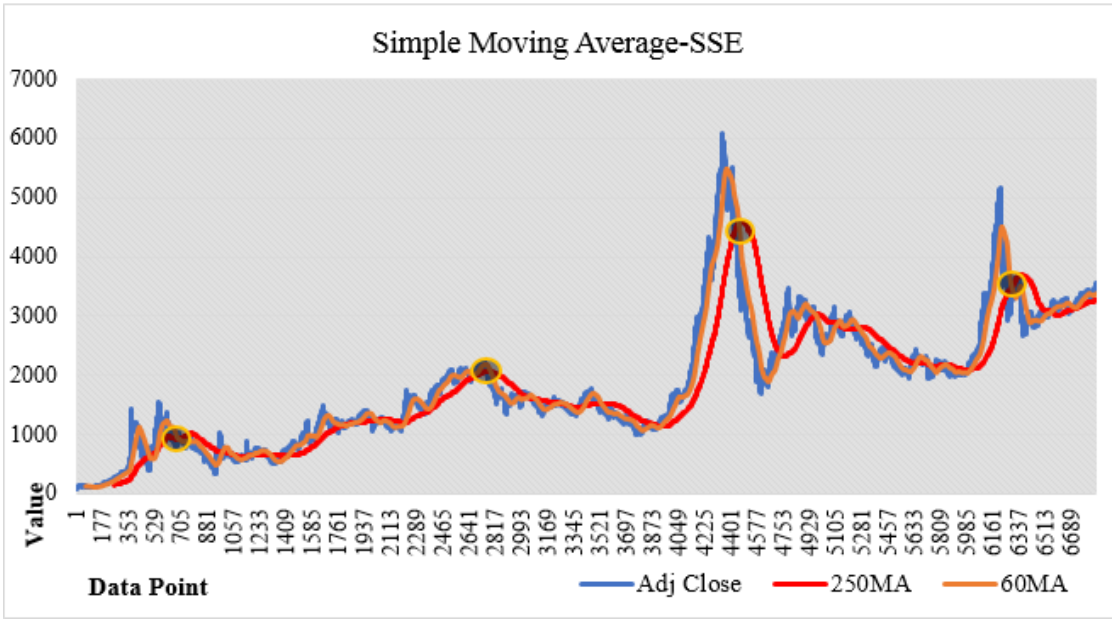


Source: https://finance.yahoo.com/, author

When we use moving average method, we may able to initiate a long/short position and identify the start of a bullish/bearish trend.

There are four yellow circle in Figure 4.1.11, which are the moments of short-term trend cross above long-term trend, we can call these moments as Golden Cross.

Figure 4.1.12- Bearish crossover of the SSE Composite Index



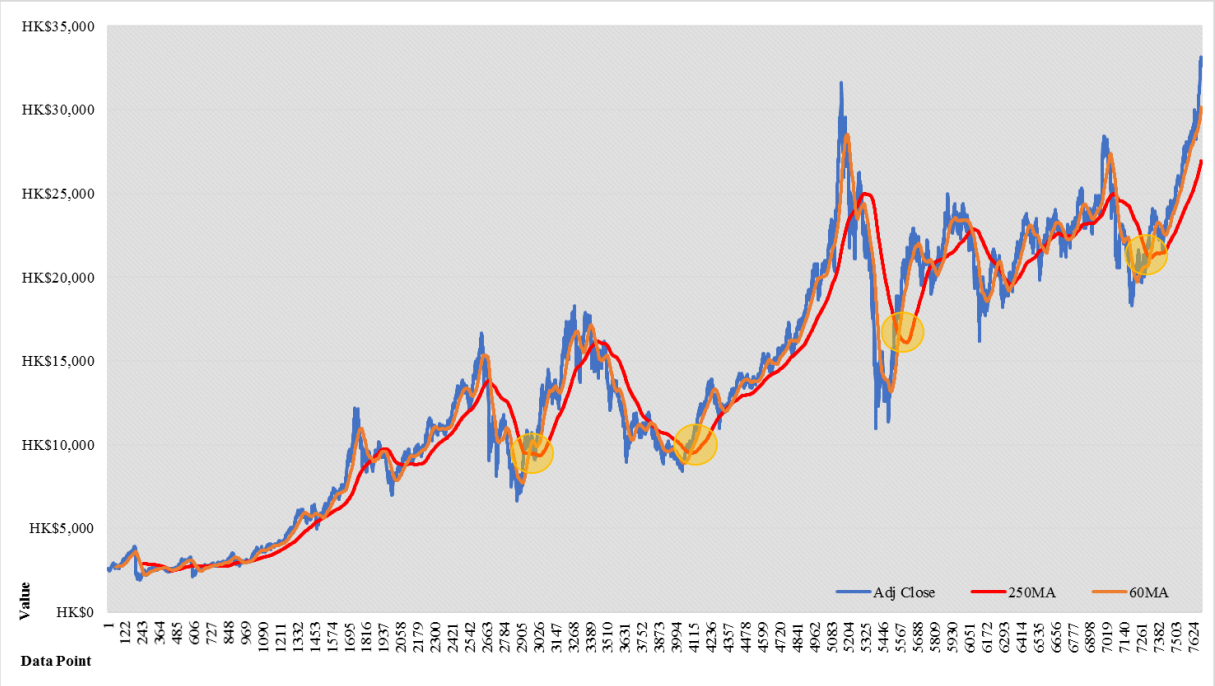
Source: https://finance.yahoo.com/, author

In these points, investors may buy as soon as they see this signal, because the short-term trend is now eclipsing the long-term trend, and we can also see that after each point of bullish average cross, the SSE Composite Index was going a bullish trend. Combined with figure 4.1.10,

we can know this point is the start of bull market in China stock market. While in the figure 4.1.12, we can see the bearish average cross, as the black circle, short-term trend was below the long-term trend, in these points, we may identify the selling signal, and the start of the bear market in China stock market.

After analysis of the mainland Chinese stock market, we can have a look of the Hong Kong stock market.

Figure 4.1.13- Bullish crossover of the Hang Seng Index



Source: https://finance.yahoo.com/, author

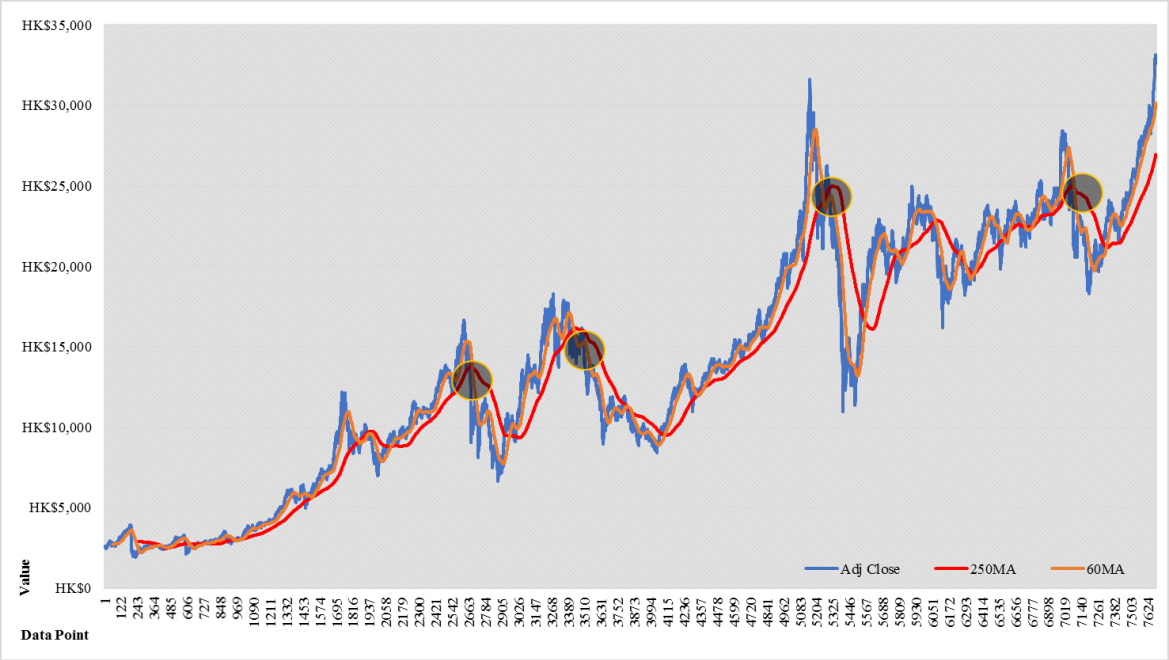
We can see from the Figure 4.1.13, there can obviously Hong Kong stock market is more fluctuating than Chinese mainland stock market, compared to the characteristic of short bull and long bear in mainland china, Hong Kong stock market is long bull and short bear. While the whole Hong Kong stock market shows an increasing trend generally.

After 2000, China mainland stock market and the economic situation is more impact on Hong Kong stock market, especially from early 2016, Hang Seng Index experienced a rising due to global economic recovery and stable recovery of China's economy.

Not only be influenced by bull market in mainland China, the bad situation or bear market will also cause Hong Kong market collapsed.

As for Hong Kong stock market, the bear market appeared shortly. The longest bear market was at 1987, at which in the Figure 4.1.14 can see the trend of HSI are recovered from bottom.

Figure 4.1.14- Bearish crossover of the Hang Seng Index



Source: https://finance.yahoo.com/, author

Through moving average method, we can see there exists about 11 times bull and bear trend since the establishment of the China mainland stock market while 9 times in Hong Kong stock market. The feature of the SSE Composite Index is that the bull market shortly and the style is majestic, and the bear market is long timeless, but Hong Kong stock market is the opposite. While from the 2017 till now, both China mainland and Hong Kong stock market are in bullish trend while shows a little probability to have a signal of sell, however, how long will this bull market continue, we need wait and we will see.

4.1.4 Japanese Stock Market

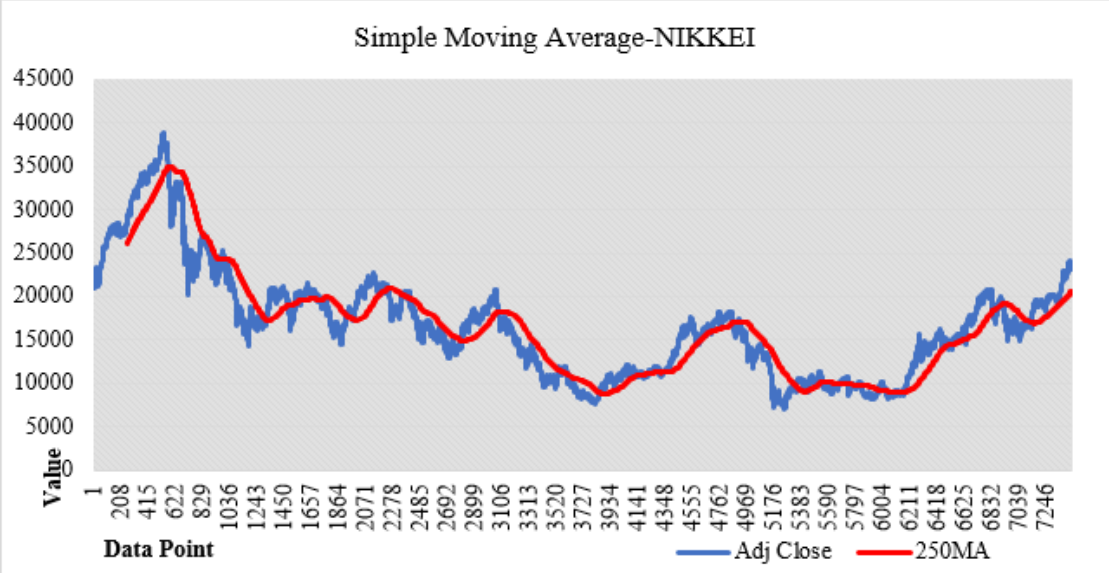
The general look of the moving average of the Nikkei 225 during 1987-2018 is in a legend downturn and it began to recover gradually in 2017. The most serious stock crash in Japan is in the 1988, we can see from the Figure 4.1.7, not only the adjusted closing price collapse from highest record, but this decreasing trend continuously affect Japan stock market till October of 2009, Nikkei 225 reach daily lowest point to 7054 points. Meanwhile, we can see the adjusted closing price cross 250-day moving average below has continue until 2012.

In the past few years, investors have been optimistic because of "*Abenomics*[5]" This series of policies aims to stimulate Japanese national consumption and has continuously

[5] It refers to a series of economic stimulus policies accelerated by Japan's 96th Prime Minister Shinzo Abe after he took office in late 2012. The most noteworthy one is the loose monetary policy. The yen exchange rate began to accelerate depreciation.

introduced measures such as interest rate cuts and tax reforms.

Figure 4.1.15- 250-day moving average of Nikkei 225

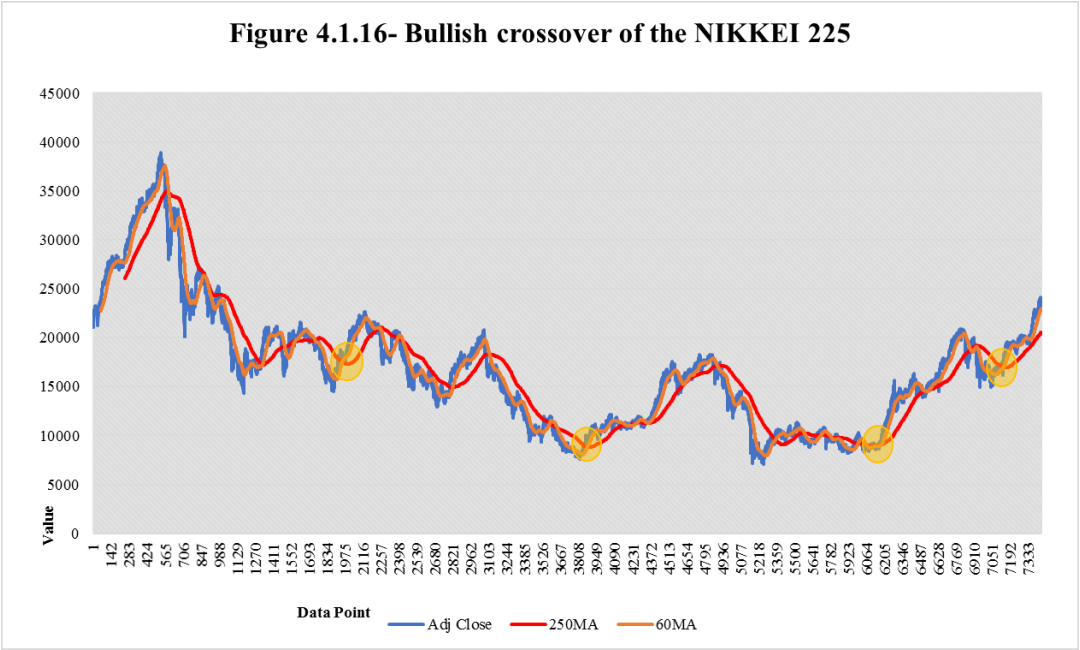


Source: https://finance.yahoo.com/, author

Investors' optimism has doubled the Japanese stock market from 2011 to 2015, as showing in the Figure 4.1.15, from 2011, the adjusted closing price cross above 250-day moving average, which is signal to enter the market.

Through combine shorter moving average and longer moving average, we can see the Figure 4.1.16. From the figure, during the long-term development of Japan stock market, there still exist several times of short bullish market, such as the Golden Cross in the figure. Compared with other stock market, the bullish market of Japan has a very short duration and

Figure 4.1.16- Bullish crossover of the NIKKEI 225

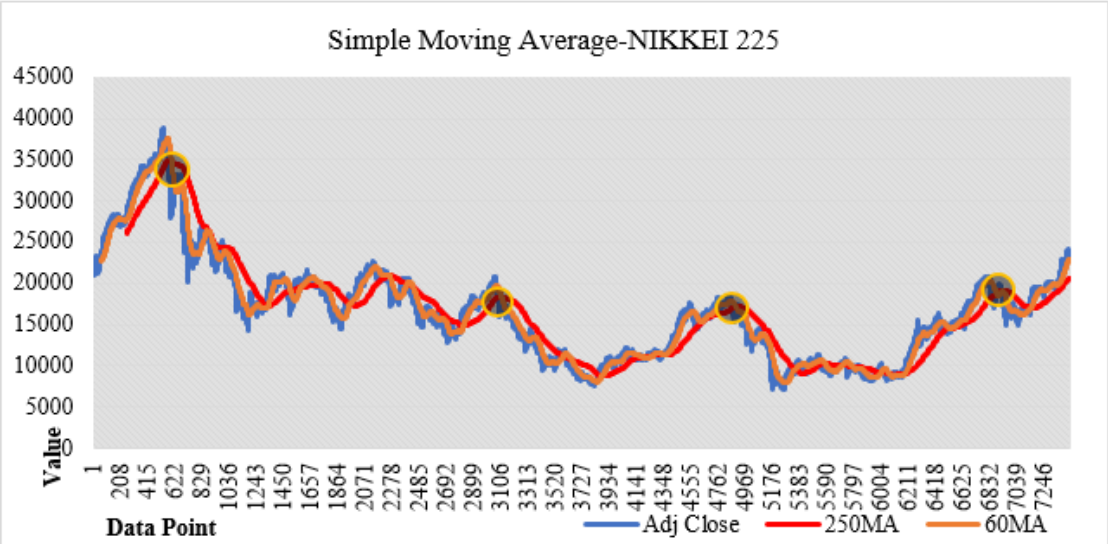


Source: https://finance.yahoo.com/, author

will soon end and enter the bearish market, while the general conditions are more bull market than bear market.

Except of Golden Cross, Japan still have several times of Death Cross, which are provide signal for exit market as showing in the Figure 4.1.17.

Figure 4.1.17- Bearish crossover of the Nikkei 225



Source: https://finance.yahoo.com/, author

Japan, like other markets in the world, has longer bull market than bear market, however, in the long run, the outlook for Japan and its stock market may start a bullish trend again in 2019.

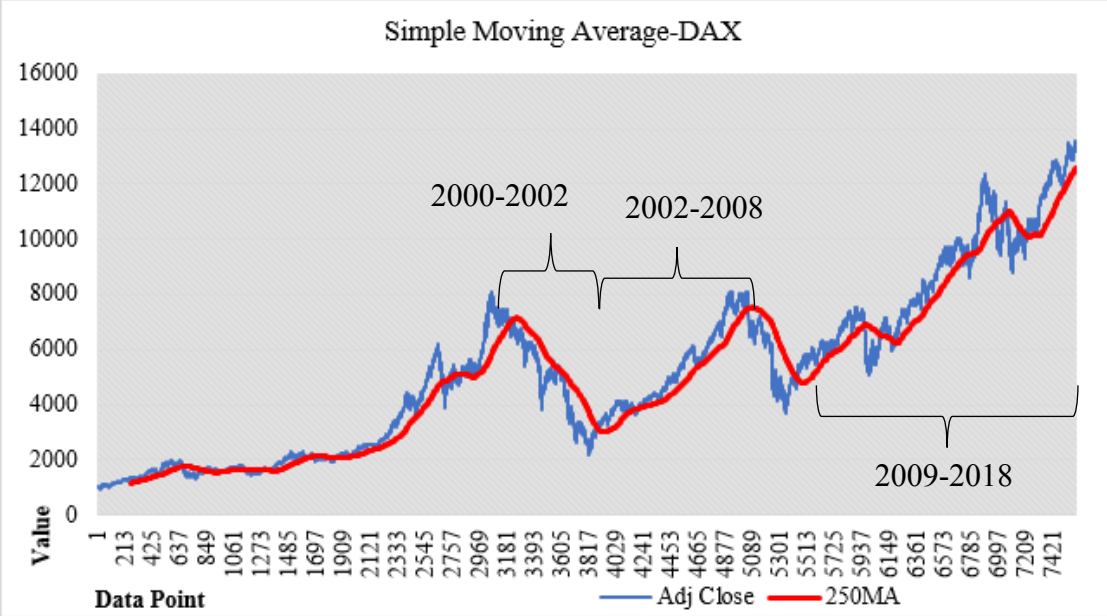
4.1.5 German Stock Market

From the figure 4.1.18, the general trend during 1987-2018 is steady increasing. Especially from 2009 till now, German stock market has been bullish for eight years, setting the record for the longest bull market. As we can see from the Figure 4.1.18, the adjusted closes cross below 250-day moving average in 2000, investors should sell as soon as this signal, because of the stock crash due to the internet stock bubble and the Deutsche Telekom.

Until 2002, the adjusted closes cross above 250-day moving average, which was a signal to buy, till 2008, subprime mortgage crisis in US has domino effect to the world, the German stock market enter bearish market again, we can also see the closes cross below 250-day moving average.

From 2009, the German economy gradually began to recover, we can see the long-term trend line shows a smooth increasing, although during this bull market, Germany experienced European debt crisis, as we mention before, due to the power of the Automotive industry, Germany has rapidly recovered from the crisis.

Figure 4.1.18- 250-day moving average of the DAX

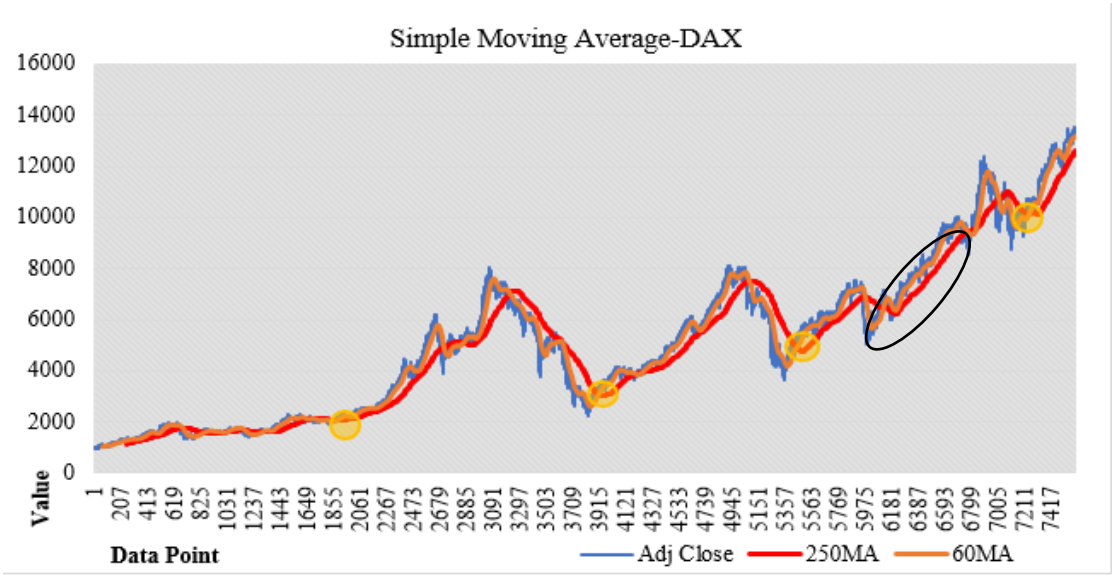


Source: https://finance.yahoo.com/, author

For more reactionary to the market, we add a 60-day moving average, from the figure 4.1.19, we can see the four times of shorter moving average cross above the longer moving average, which are the bullish crossover. After this bullish crossover, the market outlook has a certain amount of room for growth. This is the best time to enter the market, or to buy.

During 2012-2014, we can see the 60-day moving average and the 250-day moving average are parallel under the adjusted closes, indicating that it is a bull market, the increase in the market is very large, it is good signal of buying opportunity.

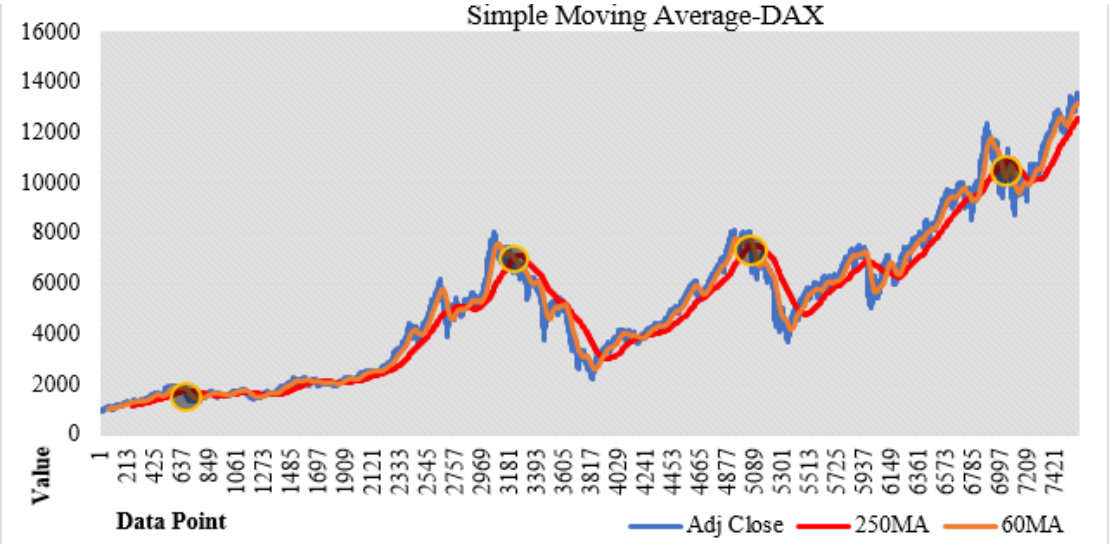
Figure 4.1.19- Bullish crossover of the DAX



Source: https://finance.yahoo.com/, author

Here we must mention the Death cross, which are also the bearish crossover, as the black circle in Figure 4.1.20, once the crossover occurs, the long-term moving average is considered a major resistance level for the market from the point forward, here resistance level is when the stock price rises under suppressing and it is difficult to exceed. We can see the Death Cross appeared in every big event point, such as 2000 internet stock crash in 2000 and global financial crisis in 2008, as well as the manufacturing downturn in 2014.

Figure 4.1.20- Bearish crossover of the DAX



Source: https://finance.yahoo.com/, author

However, the general outlook of DAX is bull market longer than bear market. Although Germans were unwilling to invest in stocks 30 years ago and feared stock risks. While more and more Germans are willing to enter the stock market in recent years, the entire German stock market is also maintaining a steadily rising bull market. This is not only the trend in global stock markets, but it also an improvement of the German's risk attitude.

4.2. Volatility Analysis of Main Stock Markets

In this part, we will use volatility method to help assess the risk of each stock market, and then we will make a comparison of five stock markets (in which divided China stock market in to mainland China and Hong Kong) based on their long-term performance.

In general, we can know volatility is important to measure the stock market, it can be used to determine the type of market trend and risk. Usually, volatility refers to the standard deviation, which is a measure of dispersion, higher standard deviation means greater risk, which means higher price erosion or the possibility of portfolio loss[6], this is the key information for

[6] Sources: Investopedia. [online]. https://www.investopedia.com/articles/06/historicalvolatility.asp

any investor.

By using Microsoft Excel, we can easily calculate the daily volatility and annualized volatility, the Table 4.2.1 shows the volatility of main stock markets based on order of daily volatility.

Table 4.2.1- Volatility of main stock markets

Country	Index	Daily volatility	Annualized volatility
United States	S&P 500	0.0111	0.1763
Germany	DAX	0.0141	0.2242
Japan	NIKKEI 225	0.0150	0.2375
China Hong Kong	Hang Seng Index	0.0167	0.2652
China mainland	SSE Composite Index	0.0228	0.3626

Source: author

While these five stock markets are use different currencies, and we can't directly compare the daily volatility which is the standard deviation, now we will calculate the coefficient variance, which is the proportion of standard deviation in mean. Here we choose same amount of data. The result shows as following table.

Table 4.2.2 Coefficient of Variance of main stock markets

Country	Index	Coefficient of Variance
Japan	NIKKEI 225	0.0000980%
China Hong Kong	Hang Seng Index	0.0001200%
Germany	DAX	0.0002523%
United States	S&P 500	0.0009337%
China mainland	SSE Composite Index	0.0012238%

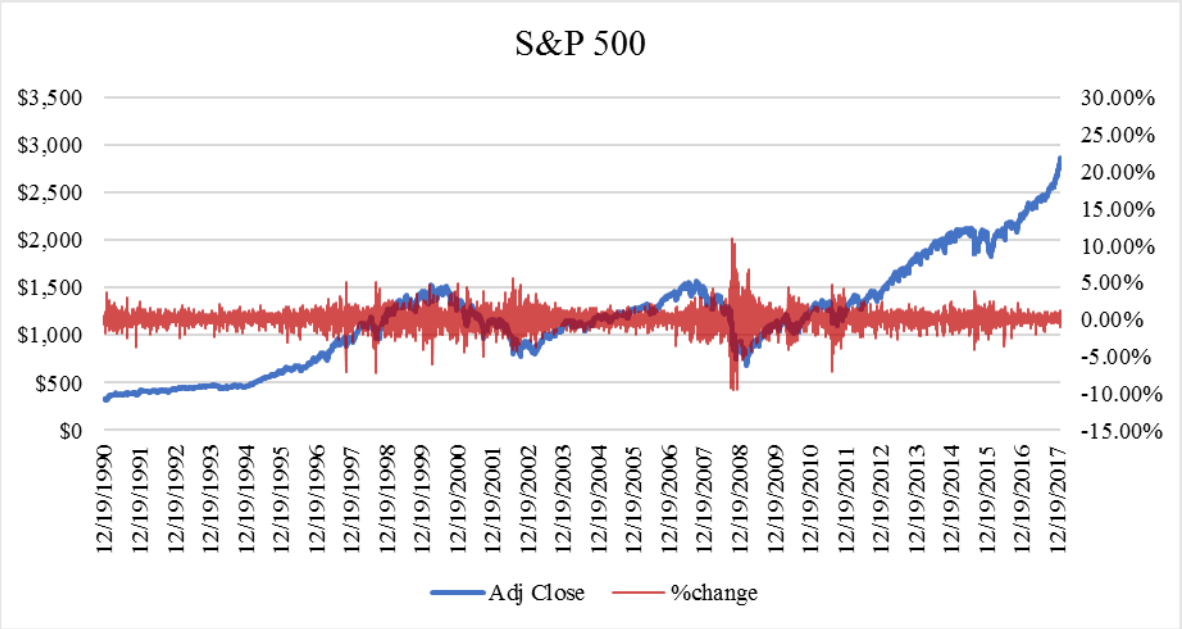
Source: author

Now, we can see the volatility coefficient of the SSE Composite Index is greater than other three stock markets, indicating that the stability of the Chinese mainland stock market is relatively poor in the long term, and it is still a less mature stock market, while Nikkei 225 has lowest volatility coefficient, means that Japan stock market is relatively stable. Next, we will see the volatility by graph in each market.

4.2.1 The United States Stock Market

As we calculated before, if we only see the standard deviation, S&P 500 has the lowest volatility. In recent years, most of the world's stock markets have steadily increased. The rebound of the S&P 500 index since 2009 has continued for nearly 8 years, making it the longest bull market in the history of the United States. We can also see from the Figure 4.2.1, the blue line represents the adjusted closing price of the S&P 500, the red line represents the change of daily price by using logarithm, the adjusted closing price still in increasing trend.

Figure 4.2.1- Volatility of S&P 500 Index



Source: https://finance.yahoo.com/, author

In long run, the annualized volatility of single-day returns has reached 17.6%, which is the smallest among the four stock markets selected in this thesis. This means that US stocks have achieved stable returns without huge volatility. That is mature stock market's performance.

However, although the volatility looks lower, while when we focus on the coefficient of variance, US stock market still need alert to suddenly fluctuations that may occur at any time.

4.2.2 Chinese Stock Market

As for Chinese stock market, we will analyze from mainland China and Hong Kong. As we can see from the Figure 4.2.3 and Figure 4.2.4, the blue line represents the adjusted closing price of Indices, the red line represents the change of daily price by using logarithm.

Figure 4.2.3- Volatility of the SSE Composite Index

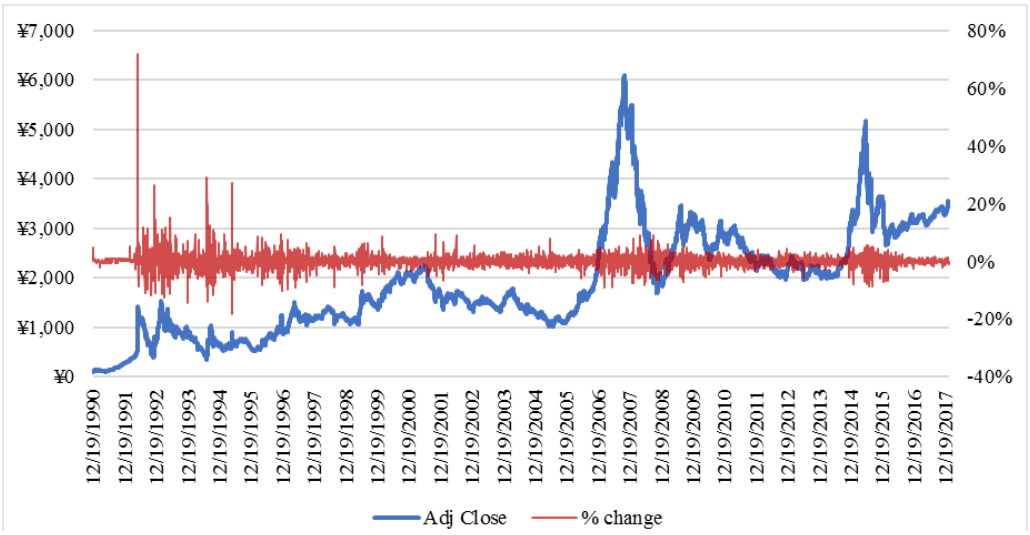
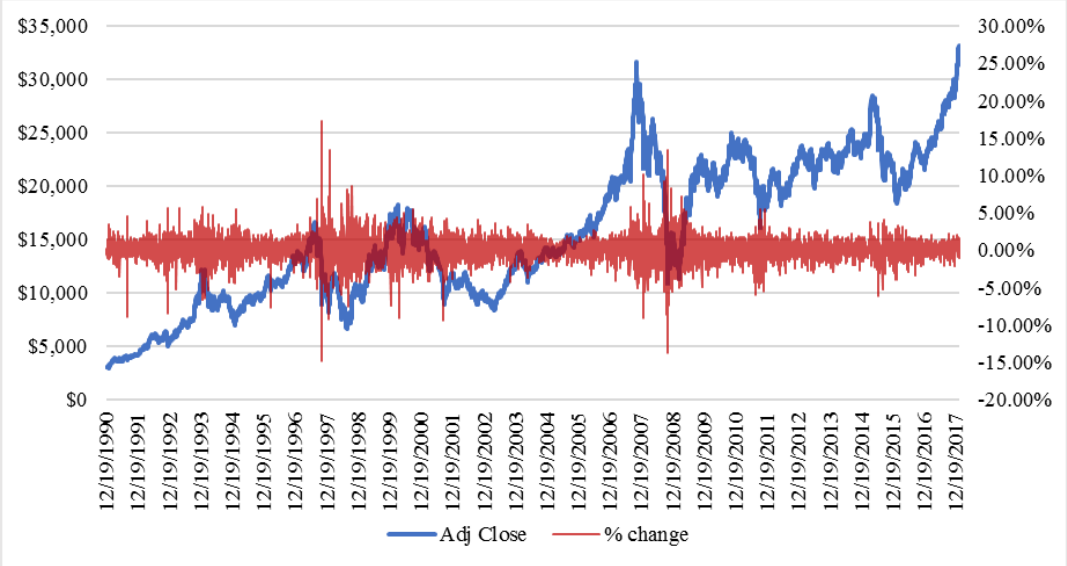


Figure 4.2.4- Volatility of the HSI



Source: https://finance.yahoo.com/, author

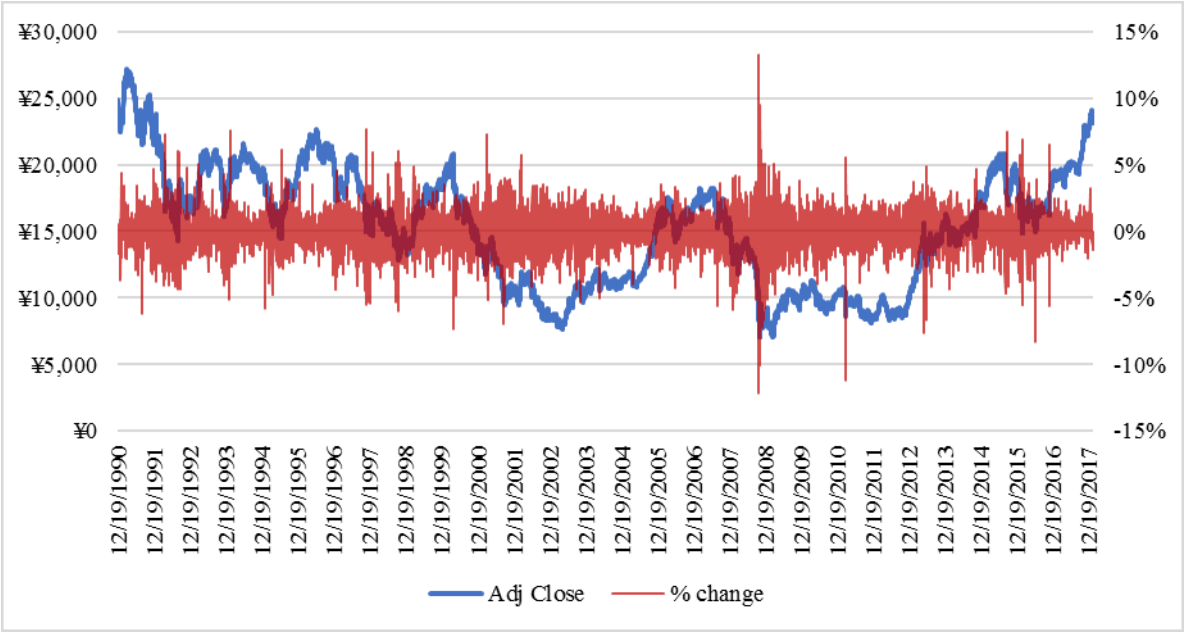
Trough Figure 4.3.3, we can obviously see the fluctuating of the daily price change, especially in the early period of China mainland stock market. This was an immature performance of the earlier China mainland stock market. In addition, except earlier non-professional stock market, during global financial crisis and other huge fluctuating of the adjusted closing price, the volatility is more obviously. From Figure 4.3.4, HSI has a relatively stable stock market, the volatility seems less fluctuation than China mainland stock market, which due to the long history and mature experience of the Hong Kong stock market.

During thirty years' development, the volatility is generally lower than before, although China mainland stock market now is in the bullish market, while China is a special country with long bear market and shorter bull market, investors still need to concern about the volatility, and prepare next bearish market.

4.2.3 Japanese Stock Market

In views of standard deviation, Japan has relatively higher volatility, while on the other hand, in views of volatility coefficient, Japan has the lowest volatility among selected stock market. As we can see from the Figure 4.2.5, when the adjusted closing price collapse in to the bottom, the higher daily volatility of the Nikkei 225, while in the top of each fluctuation, the daily volatility is lower.

Figure 4.2.5- Volatility of Nikkei 225 Index



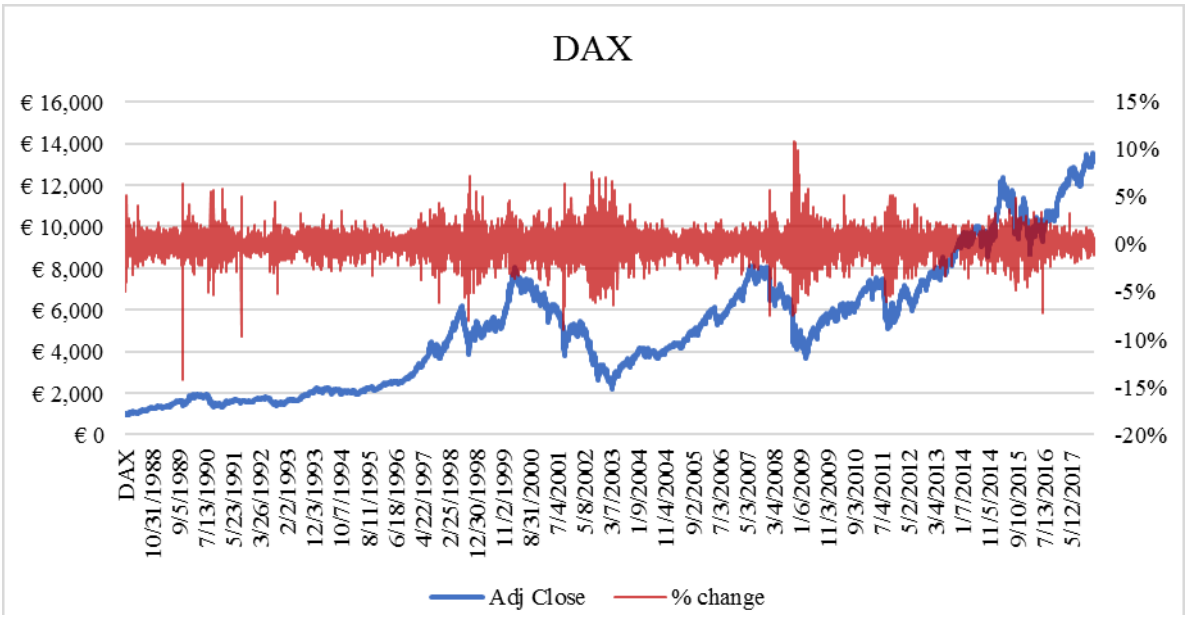
Source: https://finance.yahoo.com/, author

In general, the outlook of Japan stock market still has zone to rise to hit the new high record, and the volatility is cyclical, investors should have a review of the historical performance.

4.2.4 German Stock Market

As we can see from the Figure 4.2.6, in the bottom of every adjusted closing price collapsed, the daily volatility was higher, especially in the 1999-2002, this period was the internet bubble, which made most of German become risk averse.

Figure 4.3.6- Volatility of DAX Index



Source: https://finance.yahoo.com/, author

Similar in 2008, the global financial crisis also made the German stock market become full of volatility. In addition, we can see the volatility of the DAX is also very strong after Brexit.

Recently years, the volatility has become lower, as well as the rising trend of the DAX Index, more and more German willing to invest in the stock market, and we may expect more mature market with lower volatility while have steady return.

In general, selected stock markets in our thesis have both similar properties and different characteristics. China mainland stock market started later among the selected stock markets, which has very high volatility, Hong Kong stock market is the opposite, as well as the United States and Japan perform as mature stock market, Germany now has great improvement of steady return with lower volatility. Through this volatility analysis, we can see stock market in short-run, the volatility can be very extremely high, while in long-run, we need consider about the cyclical, the macroeconomic and other factors. However, the volatility in long-term stock market may give us a more detail and complete prediction for the future investment.

4.3 Econometrics Analysis of Main Stock Markets

We will focus on the relationship among stock index, interest rate and inflation, in which the dependent variable is the price of stock index, the explanatory variables are interest rate and inflation. Through this method, we will figure out how explanatory variables influenced dependent variable, and by modelling to estimate regression models and forecast. The most important tool to help the modelling in this chapter is STATA.

We choose monthly price of three stock indices from 1987-2017, which represent the overall performance of each market. Hang Seng Index (HSI) represent Chinese stock market and Asia stock market, Deutsche Boerse AG German Stock Index (DAX) represent Germany and Europe, and Standard & Poor's 500 (S&P 500) represents the United States and America.

Meanwhile, we choose interest rate and inflation of each country as the explanatory variables, which is present in percentage, collected from Eurostat and OECD.

Abbreviations

P- close price of stock indices (monthly)

r- interest rate of country (monthly)

i-inflation rate of country (monthly)

ln-logarithm

rate-growth rate

n- number of observations

k- number of variables

t-test: Student's t-test

f-test: Joint hypotheses test

ACF- Autocorrelation graph of residuals

PACF- Partial autocorrelation graph of residuals

CO- Cochrane-Orcutt method

VIF-Variance Inflation Factor

4.3.1 The United States Stock Market

First, we need to check the correlation between P and i or P and r, we want the result to be close to $\rho = |1|$. Through pair correlation, we can see P and r has absolute value 0.57, which means they are exist relatively strong correlation while r and i exist low correlation in ln model, which means there may have no strong correlation between these two variables. And the "0.0000" on the Table 4.3.1 under each correlation means this result are statistical significance.

After we compare the pair correlation of basic model and ln model, we can see the relationship between the dependent variables and explanatory variables of both model are weak, ln model is better.

Table 4.3.1- Pair correlation of ln model

```
pwcorr LnP r i,sig
```

	LnP	r	i
LnP	1.0000		
r	-0.5671 0.0000	1.0000	
i	-0.5526 0.0000	0.6655 0.0000	1.0000

Source: STATA, author

Through making regression analysis, we can see the coefficient of determination of both models are very low, but ln model is higher. After all, we choose ln model as the best model.

Table 4.3.2- Regression result

```
. regress LnP r i
```

Source	SS	df	MS		
				Number of obs	= 358
				F(2, 355)	= 107.26
Model	49.1015256	2	24.5507628	Prob > F	= 0.0000
Residual	81.2551573	355	.228887767	R-squared	= 0.3767
				Adj R-squared	= 0.3732
Total	130.356683	357	.36514477	Root MSE	= .47842

Source: STATA, author

Where,

$$\ln P_t = \beta_1 + \beta_2 \mathrm{r}_t + \beta_3 \mathrm{i}_t + \epsilon_t \qquad (4.1)$$

Table 4.3.3 Result of variables

		α=5%
Pt	**value**	**significance**
β1	7.529	0
β2	-0.099	0
β3	-0.139	0

Source: author

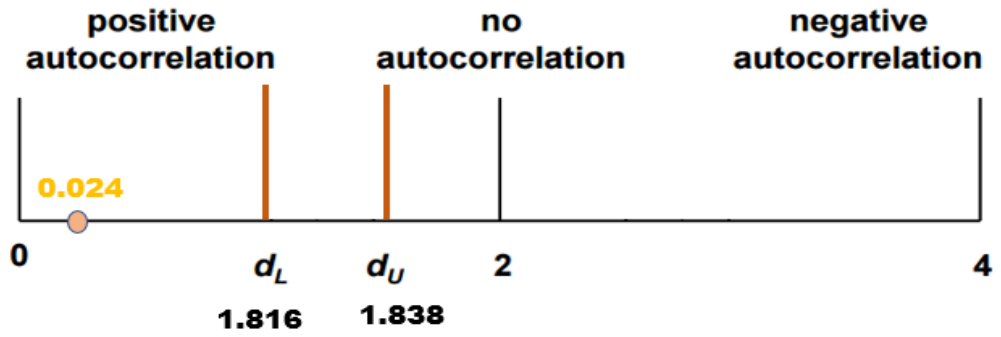
The value of each variables are shows in the Table 4.3.3, which means that when price change 1%, interest rate will drop 9.9%, inflation will decrease 1.39%, which means interest rate and inflation of China is negative related to stock index.

Autocorrelation

After that, we will check if this model exist autocorrelation. As we can see from the following picture, this model exists positive autocorrelation, and we need to eliminate.

Durbin-Watson d-statistic (4, 358) = .024099

Figure 4.3.1- Determination of DW test



Source: author

Just as we done before in last chapter, we will add a new variable because of lag. After we regress again, we can see the coefficient of determination are increasing because of the new variable, compared to the original model, it looks better.

Table 4.3.4- Regression after adding new variable

```
. regress LnP r i LnPt_1
```

Source	SS	df	MS	Number of obs	=	357
				F(3, 353)	=	26182.89
Model	128.030654	3	42.6768848	Prob > F	=	0.0000
Residual	.575373437	353	.001629953	R-squared	=	0.9955
				Adj R-squared	=	0.9955
Total	128.606028	356	.361252887	Root MSE	=	.04037

Source: STATA, author

Durbin-Watson d-statistic (4, 357) = 1.955054

Then, we test autocorrelation again by using new model, we can see from the result, it is larger than d_U, and in the area of no autocorrelation.

Heteroscedasticity

By using white test, we can see from the result, p-value less than 5%, reject H_0, this model exist heteroscedasticity, we will use weighted square method to remove.

Figure 4.3.2- White's test

```
. estat imtest, white

White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(9)      =     17.06
         Prob > chi2  =    0.0477
```

Source: STATA, author

Multicollinearity

By testing pair correlation between explanatory variables, we can see the value are all less than 0.8, which means they are no multicollinearity in this model.

Table 4.3.5- Test of multicollinearity

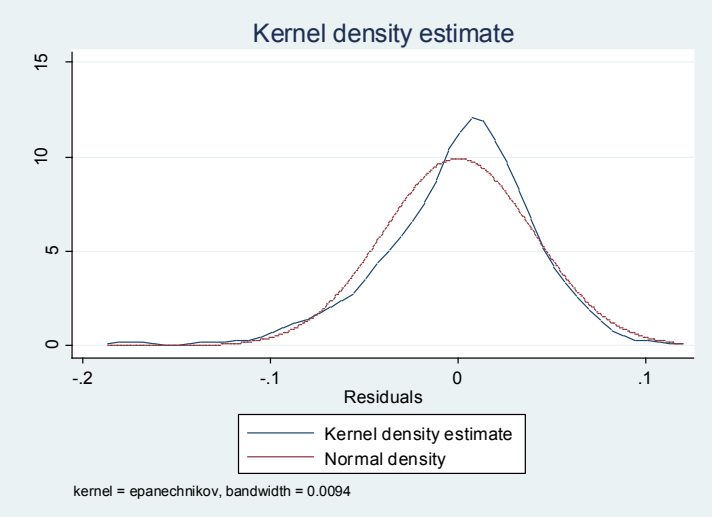
```
. pwcorr r i LnPt_1,sig
```

	r	i	LnPt_1
r	1.0000		
i	0.6655 0.0000	1.0000	
LnPt_1	-0.5663 0.0000	-0.5426 0.0000	1.0000

Source: STATA, author

Next, we will test normality of residuals by using kernel density estimate. From the graph, we can see there exist lower weak of kurtosis, and left skewed.

Figure 4.3.3-Kernel density estimate



Source: STATA, author

Meanwhile, we can use JB test to make sure for the result, and we can see the p-value is less than 5%, which means reject H_0, residuals are not normal distributed.

Table 4.3.6- JB test

Skewness/Kurtosis tests for Normality

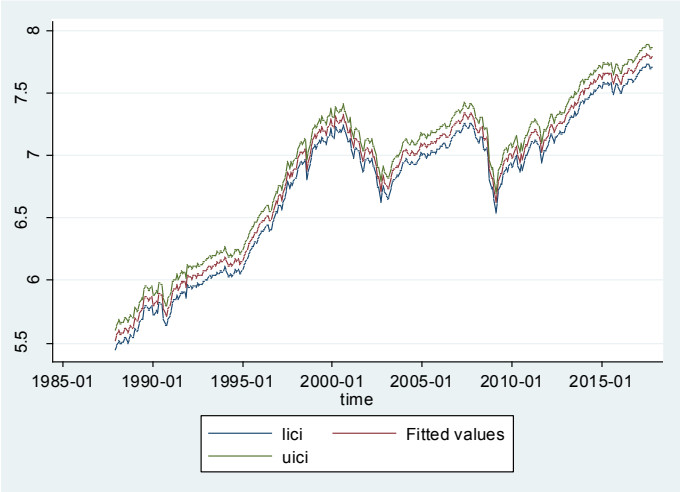
				joint	
Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
residua	357	0.0000	0.0000	39.33	0.0000

Source: STATA, author

Prediction

After all, we can use the model to predict the next three months for the S&P500, we can see it shows an increasing trend, and the *lnP* will range between the lower and higher limit.

Figure 4.3.4-Plot of the prediction



Source: STATA, author

We will make a conclusion, through regress, we can see the result in following:

$$lnP_t = 0.077 + 0.0025 \times \mathrm{R}_t - 0.0071 \times \mathrm{I}_t + 0.99 \times lnP_{t-1} + \varepsilon_t \qquad (4.2)$$

From the result of the regression analysis, we can say that when price change 1%, interest rate will increase 0.25%, inflation will decrease 0.71%, the price of S&P500 is negative related to inflation, but positive related with interest rate.

LnP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r	.0024702	.0013887	1.78	0.076	-.000261	.0052015
i	-.0070971	.0021789	-3.26	0.001	-.0113824	-.0028117
LnPt_1	.9911595	.0044733	221.57	0.000	.9823618	.9999572
_cons	.0770577	.0339418	2.27	0.024	.0103041	.1438113

Table 4.3.7- Result of variables

Source: STATA, author

4.3.2 Chinese Stock Market

As we have done before, the pair correlation between variables shows in the Table 4.3.12, we can see the correlation between $ln\,P$ and r, i are stronger than basic one, but absolute value still less than 0.8, which we need to see how to organize the model.

Table 4.3.8-Pair correlation of $ln\,P$ model

```
pwcorr LnP r i , sig
```

	LnP	r	i
LnP	1.0000		
r	-0.7073 0.0000	1.0000	
i	-0.4585 0.0000	0.7250 0.0000	1.0000

Source: STATA, author

Then we will make regression, we can see from the table, the coefficient of determination of both models are lower, which may imply the linear relationship in this model may weak.

Table 4.3.9-Regression result of basic model

```
regress P r i
```

Source	SS	df	MS		
				Number of obs	= 358
				F(2, 355)	= 175.11
Model	9.1454e+09	2	4.5727e+09	Prob > F	= 0.0000
Residual	9.2700e+09	355	26112738	R-squared	= 0.4966
				Adj R-squared	= 0.4938
Total	1.8415e+10	357	51583950.1	Root MSE	= 5110.1

Source: STATA, author

Table 4.3.10- Regression result of $ln\,P$ model

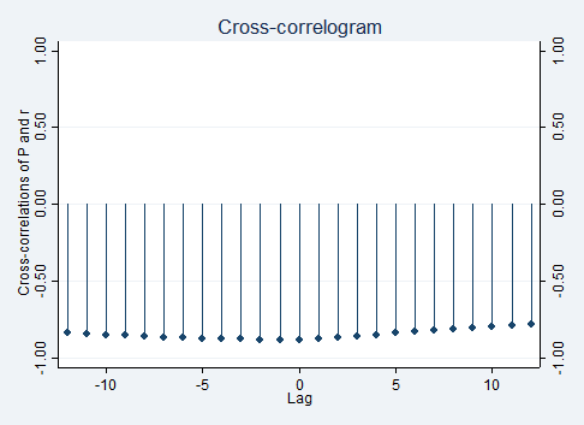
```
regress LnP r i
```

Source	SS	df	MS		
				Number of obs	= 358
				F(2, 355)	= 182.21
Model	82.4317213	2	41.2158607	Prob > F	= 0.0000
Residual	80.3002398	355	.226197859	R-squared	= 0.5065
				Adj R-squared	= 0.5038
Total	162.731961	357	.455831824	Root MSE	= .4756

Source: STATA, author

Then we need to see the relationship in time, to check if there exists time lag of the variables. Because of the lowest of the correlation is not in the 0, we can know the movement of all variables in basic model are not at same time but with some delay.

Figure 4.3.5 - Cross correlogram of basic model



Source: STATA, author

After all, we chose the ln model as the best model.

$$ln\,P_t = \beta_1 + \beta_2 r_t + \beta_3 i_t + \epsilon_t \qquad (4.3)$$

Table 4.3.11- Result from Regression

		α=5%
Pt	**value**	**significance**
β1	10.28	0
β2	-0.184	0.035
β3	0.011	0

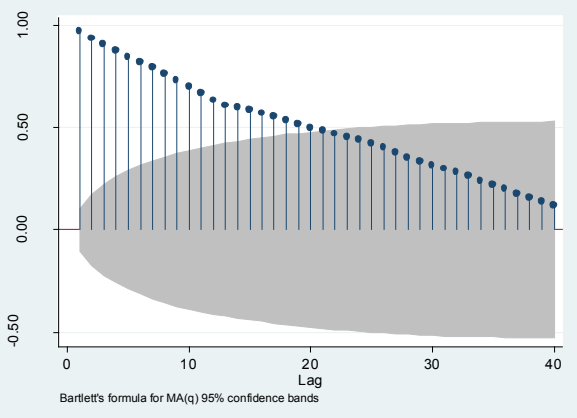
Source: author

Now, we can make an interpretation, when price change 1%, interest rate will drop 18.4%, inflation will increase 1.1%, which means interest rate of China is negative related to stock index, while inflation of China is positive related to stock index.

Autocorrelation

Next, we will check the autocorrelation of the model, we can see from Figure 4.3.6, about 95% is in the shade, but still exists 20 residuals out of grey shade, which shows there are autocorrelation.

Figure 4.3.6- Autocorrelation graph of residuals

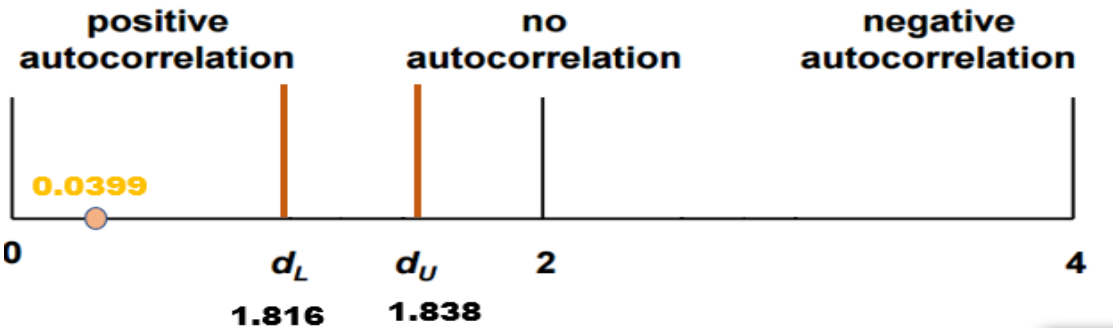


Source: STATA, author

Meanwhile, through DW test, we can see d_{crit} =0.0399, d_L =1.816, d_U =1.838 and the $d_{crit} < d_L$ which in the area of positive autocorrelation.

Durbin-Watson d-statistic (3,358) = .039965

Figure 4.3.7- Determination of DW test



Source: author

To eliminate autocorrelation, we add a new variable $ln\, P_{t-1}$ which is a lagged explained variable, as we mention before, we have found the term lagged in the model. Following equation is the former model, now we included a lagged variable.

$$ln\, P_t = \beta_1 + \beta_2 r_t + \beta_3 i_t + ln\, P_{t-1} + \epsilon_t \qquad (4.4)$$

Now, we will do regression again, which shows in the table, the R-squared is very high, and shows a strong linear relationship

Table 4.3.12- Regression result after adding new variable

```
. regress LnP r i LnPt_1
```

Source	SS	df	MS	Number of obs	=	357
				F(3, 353)	=	10503.81
Model	158.286823	3	52.7622745	Prob > F	=	0.0000
Residual	1.77317393	353	.005023156	R-squared	=	0.9889
				Adj R-squared	=	0.9888
Total	160.059997	356	.449606734	Root MSE	=	.07087

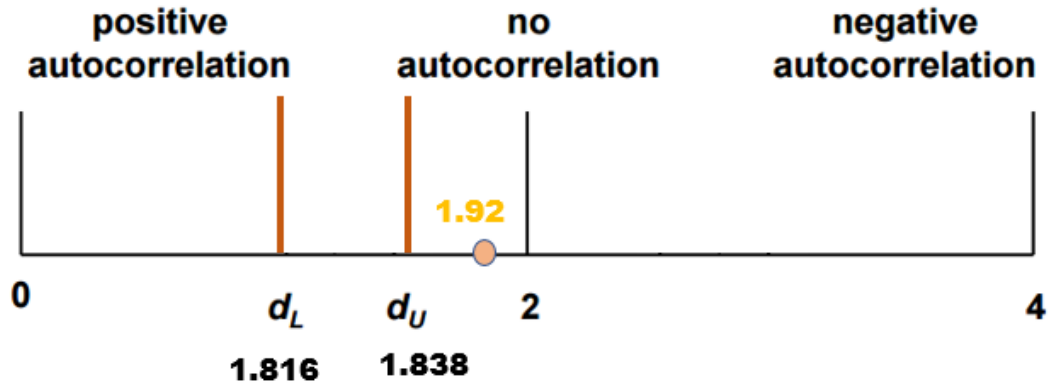
LnP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r	-.0011116	.0023888	-0.47	0.642	-.0058097	.0035866
i	-.0005449	.0007835	-0.70	0.487	-.0020858	.000996
LnPt_1	.9824588	.007946	123.64	0.000	.9668314	.9980862
_cons	.1800072	.0821439	2.19	0.029	.0184542	.3415602

Source: STATA, author

Then, we use DW test again to detect if we eliminate the autocorrelation, here because we add more variables, the numbers of explanatory variables increase to four. And result shows below.

Durbin-Watson d-statistic (4, 357) = 1.920182

Figure 4.3.8- Determination of DW test



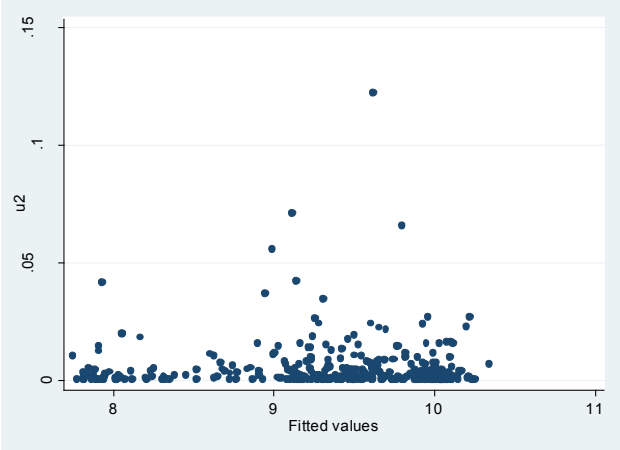
Source: author

As we can see, $d_{crit} > d_U$, and near to 2, which means the new model with lag no autocorrelation now.

Heteroscedasticity

Next step is to check if there is heteroscedasticity. We can use graphical analysis and White's test to check. We can see the Figure 4.3.9 shows graph of heteroscedasticity.

Figure 4.3.9- Heteroscedasticity



Source: STATA, author

For making sure, we can use White's test, which shows the result the p-value is less than 5%, which means reject H_0, the model is heteroscedasticity.

Figure 4.3.10- White's test

```
. estat imtest, white

White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(9)      =     24.65
         Prob > chi2  =    0.0034
```

Source: STATA, author

To remove heteroscedasticity we use weighted least squares method. But it is doesn't matter in our model.

Multicollinearity

In this part, we need to fine if our model exist multicollinearity, which means there is linear relationship between the observations of the explanatory variables.

The consequences of multicollinearity can lead estimations of parameters have large variance and covariance. Through the pair correlation, we can see the value of each explanatory variable has less than 0.8, which means no multicollinearity.

Table 4.3.13- Test of multicollinearity

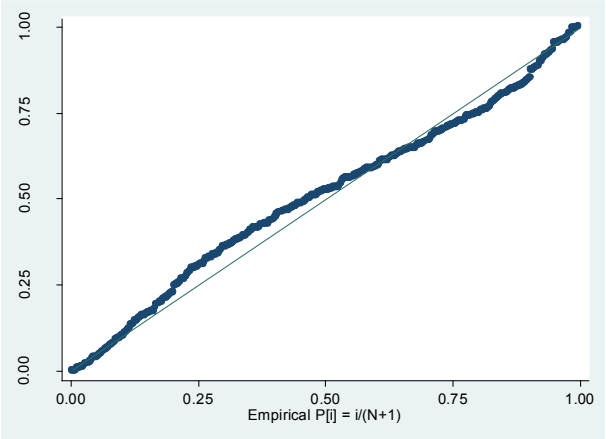
```
pwcorr r i LnPt_1,sig
```

	r	i	LnPt_1
r	1.0000		
i	0.7250 0.0000	1.0000	
LnPt_1	-0.7083 0.0000	-0.4550 0.0000	1.0000

Source: STATA, author

Next, we will test normality of residuals. The normal probability plot of the residuals is approximately linear supporting the condition that the error terms are normally distributed. We graph a standardized normal probability (P-P) plot, P-P plot is sensitive to non-normality in the middle range of data. From the Figure 4.3.11, we can see P-P plot is a straight line by plotting theoretical data against observed data, then it indicated a good match for both data distributions

Figure 4.3.11- P-P plot



Source: STATA, author

Meanwhile we can do numerical tests for testing normality. The Jarque-Bera test can be implemented, here we assume H_0 is Residuals are normal distributed, we can see the p-value is less than 5%, which means reject H_0. Therefore, the residuals are not normal distributed.

Table 4.3.14- JB test

Skewness/Kurtosis tests for Normality

				joint	
Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
residua	357	0.0137	0.0000	25.63	0.0000

Source: STATA, author

Prediction

Finally, we can use the model we modeling to predict, In the graph, we can see from 2017m9-2017m11(number 359-361) is the EX-ANTE prediction, the logarithmic price of the HSI shows an increasing trend, and range between lower limit and higher limit.

Table 4.3.15-Range of prediction

	lici	yhat	uici
359.	10.27417	10.41425	10.55433
360.	10.27995	10.42003	10.56012
361.	10.28572	10.42582	10.56591

Source: STATA, author

After all, we will make a conclusion, through regress, we can see the result in following:

Table 4.3.16-Regression result

LnP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r	-.0011116	.0023888	-0.47	0.642	-.0058097	.0035866
i	-.0005449	.0007835	-0.70	0.487	-.0020858	.000996
LnPt_1	.9824588	.007946	123.64	0.000	.9668314	.9980862
_cons	.1800072	.0821439	2.19	0.029	.0184542	.3415602

Source: STATA, author

Where,

$$lnP_t = 0.18 - 0.0011 \times R_t - 0.00054 \times I_t + 0.98 \times lnP_{t-1} + \varepsilon_t \qquad (4.5)$$

From the result of the regression, we can say, the price of HSI is negative related to inflation and interest rate, while exists lag of the effect.

4.3.3 German Stock Market

The step we used are the same, in this part, we will discuss the result only.

Through pair correlation, we can see P and r has absolute value 0.88, which means they are exist strong correlation while r and i exist low correlation in basic model, which means there may have no strong correlation between these two variables. And the "0.0000" on the Table 4.3.17 under each correlation means this result are statistical significance. And $ln\,P$ are look similar with the basic model. Table 4.3.18 shows the result.

Table 4.3.17-Pair correlation of basic model

```
pwcorr P r i,sig
```

	P	r	i
P	1.0000		
r	-0.8839 0.0000	1.0000	
i	-0.4731 0.0000	0.5954 0.0000	1.0000

Table 4.3.18 - Pair correlation of $ln\,P$ model

```
pwcorr LnP r i ,sig
```

	LnP	r	i
LnP	1.0000		
r	-0.8792 0.0000	1.0000	
i	-0.5208 0.0000	0.5954 0.0000	1.0000

Until this step, two models all look good, next we need to make regression analysis to figure out the best model for us.

Model 1(basic model)

$$P_t = \beta_1 + \beta_2 \mathrm{r}_t + \beta_3 \mathrm{i}_t + \epsilon_t \tag{4.6}$$

Model 2 (ln model)

$$ln\,P_t = \beta_1 + \beta_2 r_t + \beta_3 i_t + \epsilon_t \tag{4.7}$$

We can generate the regression result in to excel table for easy reading. As showing in the Table 4.3.19, we can see the basic model are all statistical significance, while the ln model exists significance level large than 5%, if we use this model, we may lower the significance level. Then we should to see the adjusted R-square, which is the coefficient of determination is the measure of the goodness of fit of the equation. The larger the R-square, the better the fitting data of the regression equation, and the stronger the linear relationship. In general, the R-square of both models are higher.

Table 4.3.19- Regression result of basic model

		α=5%
P_t	**value**	**significance**
β_1	9937.326	0
β_2	-1179.462	0.007
β_3	203.821	0
Adj R-square	0.7844	

Source: author

Table 4.3.20 - Regression result of *ln* model

		α=5%
$ln\ P_t$	**value**	**significance**
β_1	9.438	0
β_2	-0.2498	0.897
β_3	0.00227	0
Adj R-square	9.438	0

Source: author

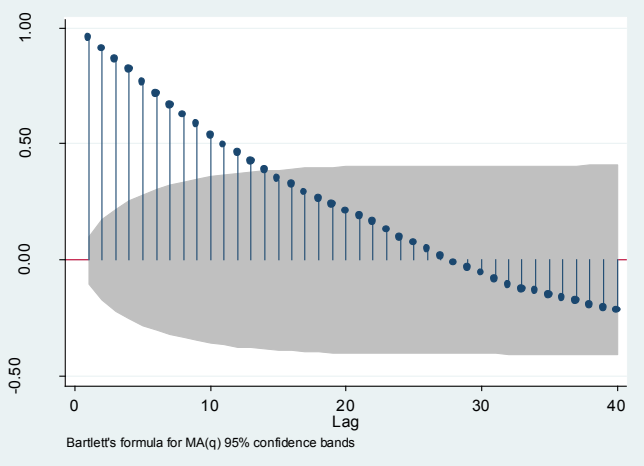
Through the comparison, we can see the basic model-model 1 is better, we can make an interpretation, when price change 1%, interest rate will drop 1179.462%, inflation will increase 203.821%, which means interest rate of Germany is negative related to stock index, while inflation of Germany is positive related to stock index.

Next, we need to check the underlying assumptions autocorrelation, heteroscedasticity and multicollinearity, to ensure better estimation of the model.

Autocorrelation

After we choose the best model and verify the statistically significant, we need to check if this model exist autocorrelation, the reason why we need to do is to avoid wrong estimation. Therefore, if our model exists autocorrelation we need to put it away. For detecting autocorrelation, we can use both graphical tests and DW test. Firstly, we use graphical tests to have a directly look. We can see from Figure 4.3.12, about 95% is in the shade, but still exists 13 residuals out of grey shade, which shows there are autocorrelation.

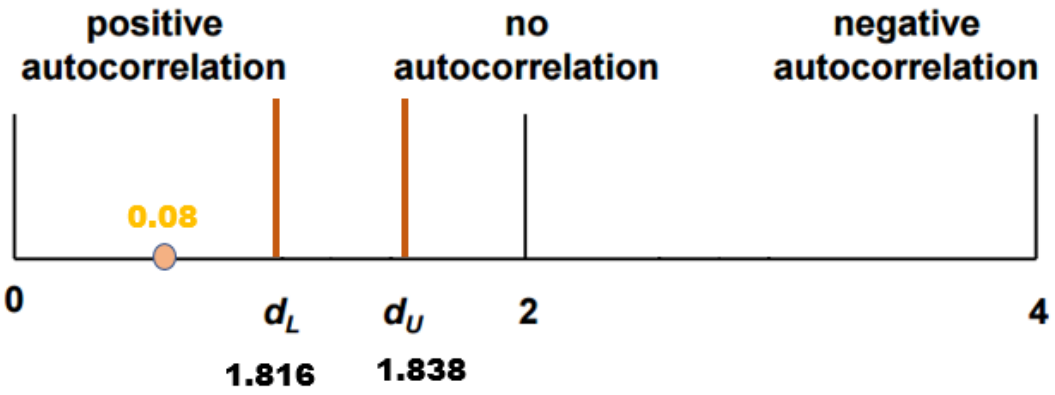
Figure 4.3.12- Autocorrelation graph of residuals



Source: STATA, author

By using DW test, we need to find the dL and dU according the number of observations.

Figure 4.3.13-Determination of DW test



Source: author

In our model, d_L=1.816, d_U =1.838, and the d_{crit} = 0.08< d_L= =1.816, which means our model exists positive autocorrelation of 1st order.

Therefore, we need to eliminate autocorrelation, we use Prais-Winsten method, in which d_{crit} = 1.846> d_U =1.838, the autocorrelation has been eliminated.

Heteroscedasticity

Next step is to check if there is heteroscedasticity. We can use White's test to compare the observed value and critical value or p-value and significance level, in our model, we can see the p-value is larger than 5%, which means fail to reject H_0, our model is homoscedasticity.

Figure 4.3.14- Process of White's test in STATA

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(14)      =     11.89
         Prob > chi2   =    0.6150
```

Source: STATA. author

Multicollinearity

In this part, we need to fine if our model exist multicollinearity, which means there is a linear relationship between the observations of the explanatory variables. The consequences of multicollinearity can lead estimations of parameters have large variance and covariance. We can compare basic model and the CO model, through calculation, we can get the VIF of basic model= 1.55> VIF of CO model =1.41, show as follow, because of value of VIF closer to 1 is better, so we can see the CO model is better.

Table 4.3.21 -VIF of basic model

```
vif
```

Variable	VIF	1/VIF
i	1.55	0.645471
r	1.55	0.645471
Mean VIF	1.55	

Table 4.3.22 - VIF of CO model

```
vif
```

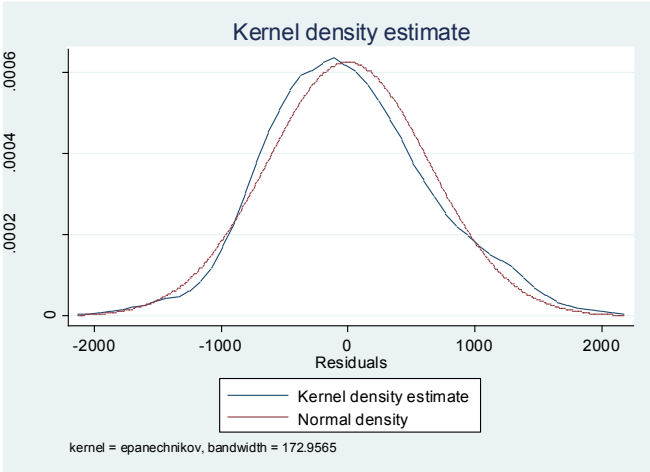
Variable	VIF	1/VIF
COI	1.41	0.708907
COR	1.41	0.708907
Mean VIF	1.41	

Source: STATA, author

Normality of residual component

In this part, we need to do the normality of residual, in case of invalid tests for regression parameters and confidence intervals are unreliable. We need to work with residuals, so we need to predict these values in STATA. We can create kernel density estimate. It can be thought of as a histogram with narrow bins and moving average. From Figure 4.3.15, we can see the kernel density estimate has a little right skewed,

Figure 4.3.15-Kernel density estimate



Source: STATA, author

Another method to test is statistical testing by using JB test, which is suitable for sample larger than 200.

Hypothesis: H_0: residuals have normal distribution

H_1: residuals have not normal distribution

Because of the P-value is lower than 5% significance level, reject H_0, residuals are not normal distributed at significance level of 5%.

Prediction

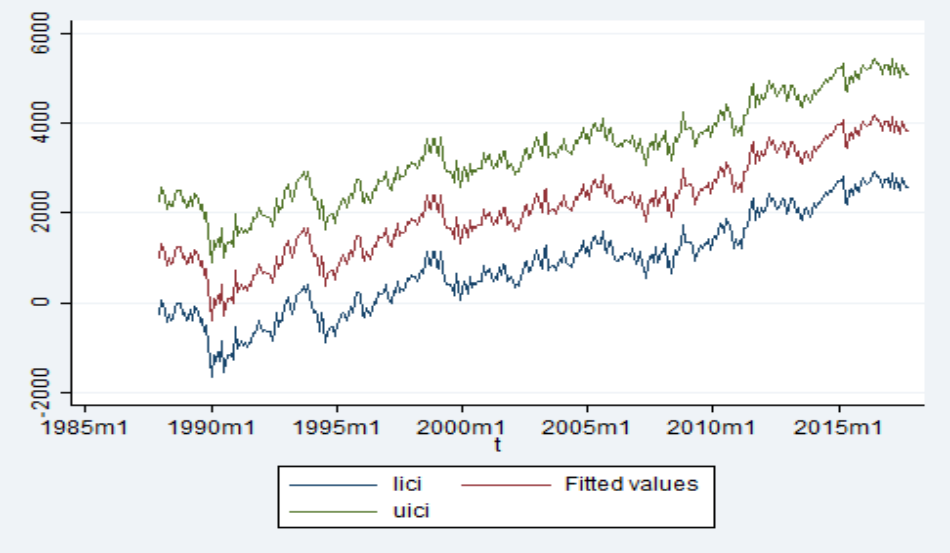
Finally, we mainly use conditional prediction (ex-ante), which means the explanatory variable values are unknown and should be predicted. From 2017m9-2017m11(number 359-361) is the EX-ANTE prediction, the price of the DAX shows an increasing trend in Figure 4.3.16, in which before 2017m9, it is ex-post prediction, the explanatory variable values are known, while 2017m9 is the ex-ante prediction, which is the result we predict by our model.

Table 4.3.23 - Prediction of dependent variable

	t	COR	COI
359.	2017m9	.1913434	.3202342
360.	2017m10	.1824823	.3178232
361.	2017m11	.1736211	.3154121

Source: STATA, author

Figure 4.3.16- Lower and upper limit of prediction



Source: STATA, author

The model of DAX

$$COP_t = \beta_1 + \beta_2 \mathrm{COR}_t + \beta_3 \mathrm{COI}_t + \epsilon_t \qquad (4.8)$$

Table 4.3.24- Result of regression

		α=5%
Pt	**value**	**significance**
β1	4001.753	0
β2	-1147.231	0.026
β3	165.0614	0

Source: author

where

$$COP_t = 4001.75 - 1147.23 \times \mathrm{COR}_t + 165.06 \times \mathrm{COI}_t + \epsilon_t \qquad (4.9)$$

From the result of the regression analysis, we can say, the price of DAX is positive related to inflation, but negative related to interest rate.

4.3.4 Summary of the Econometrics Analysis

After applying econometrics model into the most important stock markets in the world, we can see the difference between these three stock markets. In general, when the interest rate falls, the price of the stock rises; when the interest rate rises, the price of the stock falls.

As for the United States, the price is negative relative to the interest rate in long run, we can't say that is a conclusion about the US stock market, because we apply the model of logarithmic and exists lag effect. In addition, US stock market in long run exactly existed interest rate increase with stock price increasing because of the foreign invest in US stock market and the confidence of the US dollar. However, investors should not place too much

emphasis on the impact of raising interest rates on the market when making investment decisions.

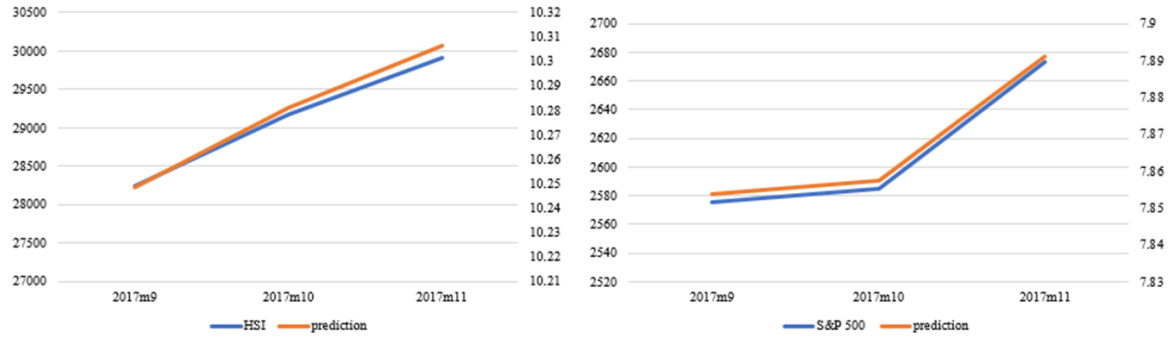
As for China, the relationship between stock price and interest rate is consistent with the theory, while the inflation is negative related with stock price, that is because China has very high real inflation than official announcement, while the relatively low inflation can stimulate the stock markets, while too high inflation will make the stock market into downturn.

As for Germany, not only the relationship between stock price and interest rate, but between stock price and inflation is reflect the theory. In my opinion, it depends on the target inflation within the European, which make reasonable changes in inflation.

In addition, we can see the prediction through modelling, Germany, the United States and China may all have rising trend in next three months, according to the reality price, we can see the prediction was almost same for the United States and China, while opposite result for Germany.

The reason caused inaccurate prediction may be the interest rate of Germany has increase shortly in 2017m10, while fall down in 2017m11, although we predict the interest rate will decrease, which may influence the price of index.

Figure 4.3.17- Result comparison of reality and prediction



Source: author

However, through this method, we have understood the relationship between stock indices price and macroeconomic indicators in selected stock market.

5 Conclusion

The objective of this thesis is assessment of long-term investing in stock markets. In this thesis, we selected four representative stock markets to analyze the development during past 30 years, which followed by: The United States, China, Japan and Germany. These four stock markets represent America, Asia and Europe. Therefore, we can assess the global stock markets through the important markets and distinguish the different characteristics and behavior of each market.

In Chapter 2, we introduced the basic characteristics of stock markets, which include stock exchanges, participants in the stock markets as well as the indices. In addition, we described the methods we will use in the Chapter 4, one is econometrics, and the other one is technical analysis-moving average and volatility. Chapter 3 focused on the history and development of selected stock markets through the historical price of the representative indices.

In Chapter 4, we applied the methods we introduced in Chapter 2. By calculating the moving average yield of selected stock indices, compared with one-year average, long-term investing shows more stable and high profitability. The most special index is the Nikkei 225, until 25-year average yield had positive return, which may provide the investor in Japan stock market that invest in long-term at least 25 years can have more yield than in short-term. Through the cycle in moving average of historical price of each market, we can summarize the future stock markets of the world may experience a bear market, especially in the US stock market, the longest bull market may end in near future. In addition, as for volatility analysis, we can see the United States and Japan has relatively low volatility, while Chinese stock market is immature to have very high volatility.

From econometrics analysis, we have defined the relationships between a stock indices and interest rate, inflation. For selected countries, we have summarized the difference among three stock markets, such as China has very high real inflation than public announcement, which caused inflation negatively related to stock indices. While for Germany, the inflation is positively related to stock indices, because of the target inflation within Europe, thus stimulate the German stock market. Meanwhile, the prediction based on model shows both Germany and the United States will rise while China has slightly decreasing.

Through analysis, we can see long-term investing is more profitability and stable. In addition, global stock market may enter a new bear market.

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List of Abbreviations

DJIA: Dow Jones Industrial Average

EUR: Euro

HKEX: Hong Kong Stock Exchange

IPO: Initial Public Offerings

JPY: Japanese Yan

NYSE: New York Stock Exchange

OTC: Over-The-Counter

RMB: Chinese Renminbi

S&P: Standard & Poor's

SMA: Simple Moving Average

SSE: Shanghai Stock Exchange

USD: United States Dollar

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Herewith I declare that

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Ostrava dated 25.04.2018

Xiaoshan Feng

Student's name and surname

List of Annexes

Annex 1 Yearly Average Yield of Selected Stock Indices from 1991-2017

Year	S&P 500	SSE	HSI	Nikkei 225	DAX
1991	30.23%	84.66%	42.11%	-3.63%	13.53%
1992	7.49%	99.19%	28.28%	-26.36%	-2.46%
1993	9.97%	6.62%	115.67%	2.91%	46.60%
1994	1.33%	-25.23%	-31.10%	13.24%	-7.00%
1995	37.20%	-15.42%	22.98%	0.74%	7.78%
1996	22.68%	49.78%	33.53%	-2.55%	27.40%
1997	33.10%	26.30%	-20.29%	-21.19%	46.67%
1998	28.34%	-4.04%	-6.29%	-9.29%	18.52%
1999	20.89%	17.48%	68.80%	36.79%	38.98%
2000	-9.03%	41.69%	-11.00%	-27.19%	-7.54%
2001	-11.85%	-20.62%	-24.50%	-23.52%	-19.79%
2002	-21.97%	-17.52%	-18.21%	-18.63%	-43.94%
2003	28.36%	10.27%	34.92%	24.46%	37.08%
2004	10.74%	-15.40%	13.15%	7.61%	7.34%
2005	4.83%	-8.33%	4.54%	40.23%	27.07%
2006	15.61%	130.43%	34.20%	6.92%	21.98%
2007	5.48%	96.66%	39.31%	-11.13%	22.29%
2008	-36.55%	-65.39%	-48.27%	-42.12%	-40.37%
2009	25.94%	79.98%	52.02%	19.03%	23.85%
2010	14.82%	-14.31%	5.32%	-3.01%	16.06%
2011	2.10%	-20.30%	-19.97%	-17.34%	-14.69%
2012	15.89%	3.17%	22.91%	22.95%	29.06%
2013	32.15%	-6.75%	2.87%	56.72%	25.48%
2014	13.52%	52.87%	1.28%	7.12%	2.65%
2015	1.38%	9.41%	-7.16%	9.07%	9.56%
2016	11.77%	-12.31%	0.39%	0.42%	6.87%
2017	21.64%	6.56%	35.99%	19.10%	12.51%

Source: http://www.1stock1.com/1stock1_112.htm, author

Annex 2 Five-year Average Yield of Selected Stock Indices from 1991-2017

Year	S&P 500	SSE	HSI	Nikkei 225	DAX
1991-1995	17.24%	29.96%	35.59%	-2.62%	11.69%
1992-1996	15.73%	22.99%	33.87%	-2.40%	14.46%
1993-1997	20.86%	8.41%	24.16%	-1.37%	24.29%
1994-1998	24.53%	6.28%	-0.23%	-3.81%	18.67%
1995-1999	28.44%	14.82%	19.75%	0.90%	27.87%
1996-2000	19.20%	26.24%	12.95%	-4.69%	24.81%
1997-2001	12.29%	12.16%	1.34%	-8.88%	15.37%
1998-2002	1.28%	3.40%	1.76%	-8.37%	-2.75%
1999-2003	1.28%	6.26%	10.00%	-1.62%	0.96%
2000-2004	-0.75%	-0.32%	-1.13%	-7.45%	-5.37%
2001-2005	2.02%	-10.32%	1.98%	6.03%	1.55%
2002-2006	7.51%	19.89%	13.72%	12.12%	9.91%
2003-2007	13.00%	42.73%	25.22%	13.62%	23.15%
2004-2008	0.02%	27.59%	8.59%	0.30%	7.66%
2005-2009	3.06%	46.67%	16.36%	2.59%	10.96%
2006-2010	5.06%	45.47%	16.52%	-6.06%	8.76%
2007-2011	2.36%	15.33%	5.68%	-10.91%	1.43%
2008-2012	4.44%	-3.37%	2.40%	-4.10%	2.78%
2009-2013	18.18%	8.36%	12.63%	15.67%	15.95%
2010-2014	15.70%	2.94%	2.48%	13.29%	11.71%
2011-2015	13.01%	7.68%	-0.01%	15.70%	10.41%
2012-2016	14.94%	9.28%	4.06%	19.26%	14.72%
2013-2017	16.09%	9.96%	6.67%	18.49%	11.41%

Source: http://www.1stock1.com/1stock1_112.htm, author

Annex 3 Ten-year Average Yield of Selected Stock Indices from 1991-2017

Year	S&P 500	SSE	HSI	Nikkei 225	DAX
1991-2000	18.22%	28.10%	24.27%	-3.65%	18.25%
1992-2001	14.01%	17.58%	17.61%	-5.64%	14.92%
1993-2002	11.07%	5.90%	12.96%	-4.87%	10.77%
1994-2003	12.91%	6.27%	4.88%	-2.71%	9.82%
1995-2004	13.85%	7.25%	9.31%	-3.28%	11.25%
1996-2005	10.61%	7.96%	7.47%	0.67%	13.18%
1997-2006	9.90%	16.03%	7.53%	1.62%	12.64%
1998-2007	7.14%	23.06%	13.49%	2.63%	10.20%
1999-2008	0.65%	16.93%	9.29%	-0.66%	4.31%
2000-2009	1.16%	23.18%	7.62%	-2.43%	2.80%
2001-2010	3.54%	17.58%	9.25%	-0.02%	5.16%
2002-2011	4.94%	17.61%	9.70%	0.60%	5.67%
2003-2012	8.72%	19.68%	13.81%	4.76%	12.97%
2004-2013	9.10%	17.98%	10.61%	7.99%	11.81%
2005-2014	9.38%	24.80%	9.42%	7.94%	11.34%
2006-2015	9.03%	26.58%	8.25%	4.82%	9.59%
2007-2016	8.65%	12.30%	4.87%	4.17%	8.08%
2008-2017	10.27%	3.29%	4.54%	7.19%	7.10%

Source: http://www.1stock1.com/1stock1_112.htm, author

Annex 4 Fifteen-year Average Yield of Selected Stock Indices from 1991-2017

Year	S&P 500	SSE	HSI	Nikkei 225	DAX
1991-2005	12.82%	15.30%	16.84%	-0.43%	12.68%
1992-2006	11.85%	18.35%	16.31%	0.28%	13.25%
1993-2007	11.71%	18.18%	17.05%	1.29%	14.90%
1994-2008	8.61%	13.38%	6.12%	-1.71%	9.10%
1995-2009	10.25%	20.39%	11.66%	-1.32%	11.15%
1996-2010	8.76%	20.47%	10.48%	-1.57%	11.71%
1997-2011	7.39%	15.79%	6.92%	-2.56%	8.90%
1998-2012	6.24%	14.25%	9.80%	0.38%	7.73%
1999-2013	6.49%	14.07%	10.41%	4.78%	8.19%
2000-2014	6.00%	16.43%	5.90%	2.81%	5.77%
2001-2015	6.70%	14.28%	6.16%	5.22%	6.91%
2002-2016	8.27%	14.83%	7.82%	6.82%	8.69%
2003-2017	11.18%	16.44%	11.43%	9.34%	12.45%

Source: http://www.1stock1.com/1stock1_112.htm, author

Annex 5 Twenty-year Average Yield of Selected Stock Indices from 1991-2017

Year	S&P 500	SSE	HSI	Nikkei 225	DAX
1991-2010	10.88%	22.84%	16.76%	-1.83%	11.70%
1992-2011	9.47%	17.59%	13.65%	-2.52%	10.29%
1993-2012	9.89%	12.79%	13.39%	-0.05%	11.87%
1994-2013	11.00%	12.12%	7.75%	2.64%	10.81%
1995-2014	11.61%	16.03%	9.37%	2.33%	11.29%
1996-2015	9.82%	17.27%	7.86%	2.75%	11.38%
1997-2016	9.28%	14.16%	6.20%	2.90%	10.36%
1998-2017	8.70%	13.18%	9.02%	4.91%	8.65%

Source: http://www.1stock1.com/1stock1_112.htm, author

Annex 6 Twenty five-year Average Yield of Selected Stock Indices from 1991-2017

Year	S&P 500	SSE	HSI	Nikkei 225	DAX
1991-2015	11.31%	19.81%	13.40%	1.67%	11.44%
1992-2016	10.57%	15.93%	11.74%	1.84%	11.18%
1993-2017	11.13%	12.22%	12.04%	3.65%	11.78%

Source: http://www.1stock1.com/1stock1_112.htm, author